LAKE ASSESSMENT PROJECT REPORT
LAKE ANDES
CHARLES MIX COUNTY, SOUTH DAKOTA

SOUTH DAKOTA CLEAN LAKES PROGRAM

DIVISION OF WATER RESOURCES MANAGEMENT

SOUTH DAKOTA

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

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INTRODUCTION

The purpose of this report is to present and discuss information gathered from the investigation conducted on Lake Andes and its watershed. The study site can be located by referring to Figure 1. The study was conducted from October, 1990, to May, 1992. The cooperating parties involved with this project were the State of South Dakota Department of Environment and Natural Resources (SD DENR), Lake Andes-Wagner Water Sytems, the Charles Mix County Conservation District, the Charles Mix County Soil Conservation Service, and the U.S. Fish and Wildlife Service.

The study was initiated, at local request, to assess the current status of the lake and its watershed, to determine water quality problems, to identify pollution sources, and develop specific restoration alternatives. This report addresses the results of the analyzed data and provides recommendations for restoration within the lake itself and the watershed.

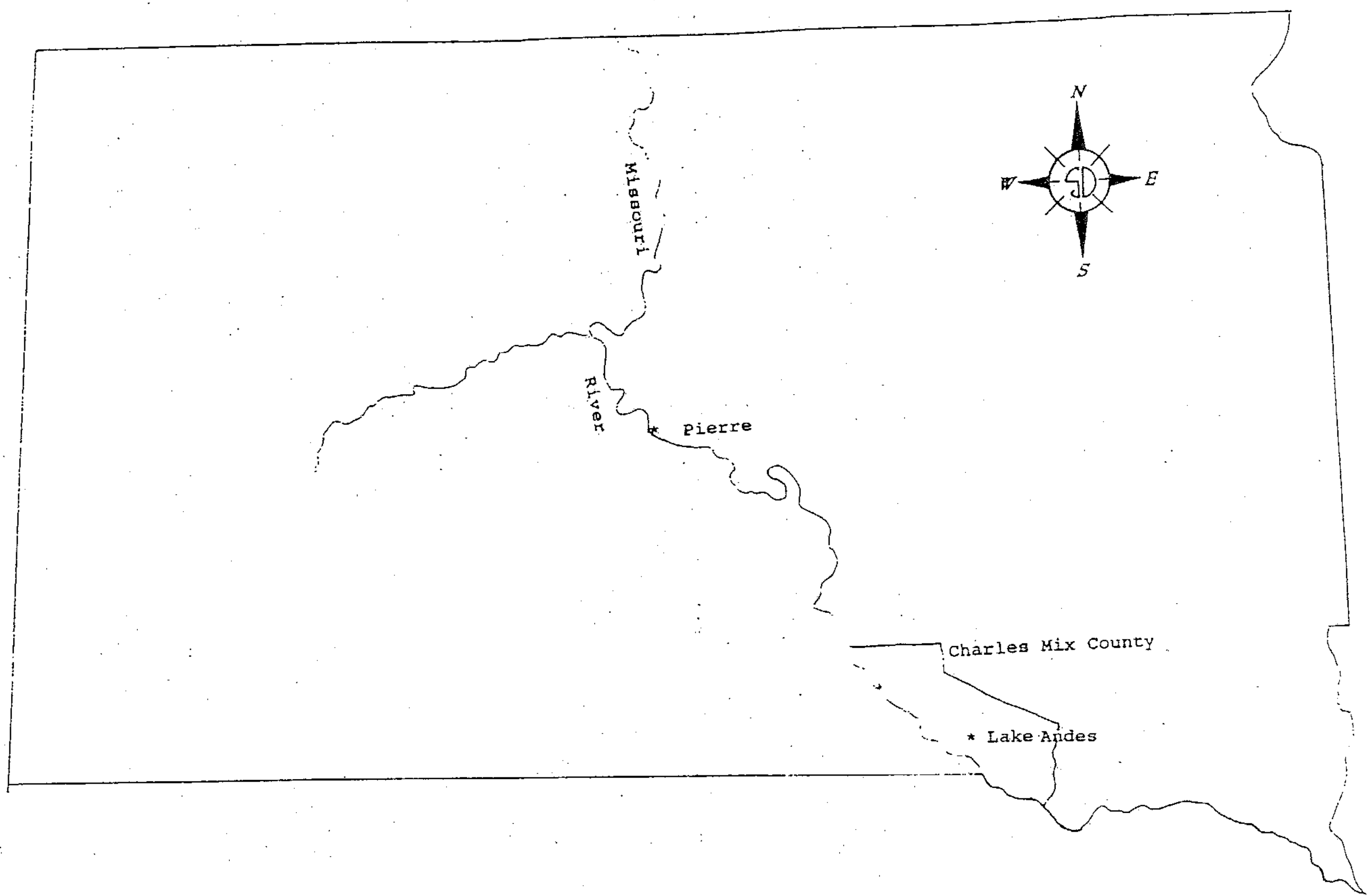
STUDY SITE DESCRIPTION

The Lake Andes watershed contains 95,723 acres of primarily agricultural land (Figure 2). From the lake, overflow water is discharged into the Missouri River through an outlet structure constructed in 1934 on the south side of the south unit. The city of Lake Andes is located on the southwestern shore of the southern unit of the lake in Charles Mix County. Figure 2 shows the location of the Lake Andes watershed in relation to Charles Mix and Douglas Counties in southcentral South Dakota.

The lake has a surface area of 4,616 acres, a mean depth of 3.2 feet, and a maximum depth of 10 feet. The long axis of Lake Andes lies in a northeast to southwest orientation and is divided up into three units which are separated by two dikes that were also constructed in 1934. Andes Creek is the most prominent tributary within the watershed and discharges into the north unit of Lake Andes.

The climate for the southcentral region of the state is dry to semi-arid and the average annual precipitation from 1981 to 1990 was 25.08 inches. Evaporation and transpiration rates are greatest during April through September and average 41.2 inches a year (1981 through 1990). The mean temperature is 47.8°F and ranged from -28 (taken from data recorded up to 1977) to 111°F (recorded in 1957) (Agricultural Engineering Department, SDSU,

Figure 1. Map of South Dakota showing location of Lake Andes.



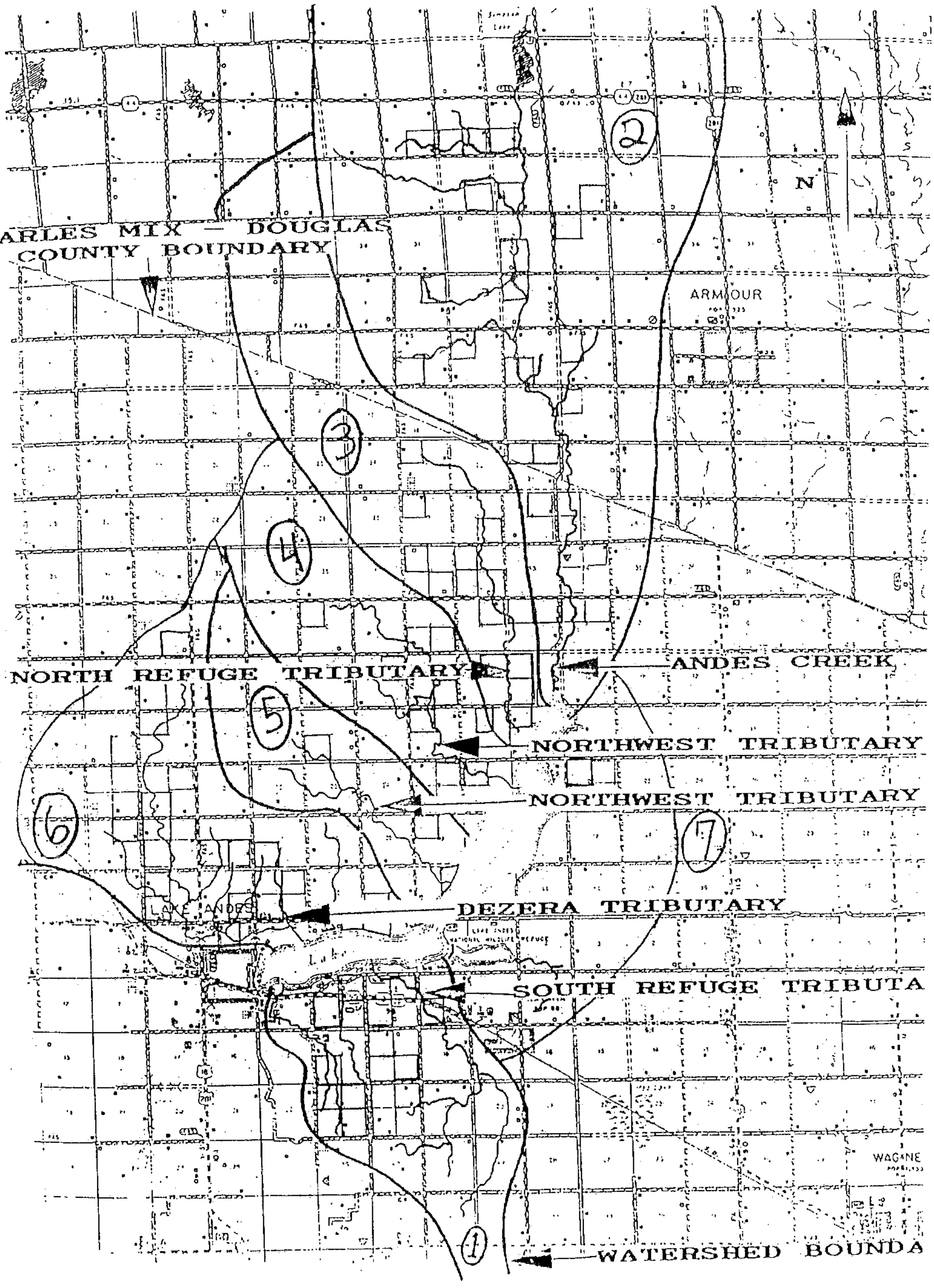


Figure 2. The Lake Andes Watershed.

Brookings, South Dakota). The lowest and highest precipitation rates occur in December (.63 inches) and June (3.58 inches). In 1990, the population within a 65 kilometer radius of the lake was 123,134 of which 16,555 were urban and 106,579 were rural (Census Data Center, Brookings, South Dakota, 1990).

WATERSHED

The entire watershed of Lake Andes lies in a hummocky glacial moraine in an east-west trending sag located within the Great Plains physiographic province coteau du Missouri. The counties of Charles Mix and Douglas encompass 1540 square miles of this geologic area. During the Pleistocene epoch, glaciers left ground end and stagnation moraine deposits, and the meltwater streams from wasting glaciers left collapsed, undifferentiated, and valleytrain deposits. Quaternary deposits and formations comprise alluvial valley fill loess, and other windblown deposits (USGS, 1975,1977). The dominant bedrock formations that are found within Lake Andes watershed are Niobrara Marl, Pierre and Carlile shale and are, depending on the location, approximately 300 feet beneath the surface (USGS, 1972). This natural lake and a portion of the watershed are found in a bedrock valley that is partly buried by ground moraine. It is part of a hummocky area which is separated by a broad drainage basin containing Lake Andes and Choteau Creek. Minor aquifers of concern are the Choteau and Corsica, whereas the more important bedrock aquifers are the Dakota, Codell, and Niobrara. The Dakota is the most important because it is a potential source of water throughout the area with a sufficient static head for artesian wells(USGS, 1977). Along Andes Creek, which drains into the North Unit of Lake Andes, the alluvium can be as much as 15 feet thick and is dark gray to black silty clay locally containing sand and gravel (USGS, 1975).

BACKGROUND/HISTORICAL INFORMATION

General History

Lake Andes is a 4,616 acre natural lake which had a history of going dry on average every 13.8 years before the construction of the outlet structure. Subsequent to this construction the average period of time has decreased to 11.5 years. Records and old accounts have indicated that the lake has gone dry in the following years: 1863, 1870, 1878, 1883, 1893-1894, 1933-34, 1939, 1959, 1975-76, and 1981 (Decker, 1982). At present the lake is in a state of stagnation and will continue in this state or eventually become dry unless a considerable amount of rainfall and snowmelt occur in the next few years. Certain structures have been constructed on both the watershed and the Lake to allow for more effective management of the water. However, these structures do not deter the high evaporation rates of this semiarid region.

In 1922 Congress passed a bill establishing a high water elevation of 1437.25 feet msl for Lake Andes via the construction of an artificial outlet in 1934. This structure permanently lowered the high water elevation of 1450 feet msl required to overflow the natural outlet by 12.75 feet. Other structures involved with the Lake management were:

1) A dam project constructed on Garden Creek which diverted its respective watercourse easterly via one and one-half miles of open ditch to Hutchinson Creek. This then discharged into the south end of Lake Andes. This diversion was later plugged as a result of flash floods and the absence of flowage easements.

2) A dike and control structure constructed in 1936 on Owens Bay which allowed the water level in Owens Bay to be maintained at an elevation of 1443.55 feet.

3) In 1938-39 under the direction of the Bureau of Biological Survey, two dikes were built across Lake Andes to sub-impound the water. This was done in hopes that the dikes would aid in the retention of water during dry years allowing fish and wildlife to propagate. As a result of the dikes, the water elevation was allowed to be maintained at an elevation below that of the mandated high water elevation mark of 1437.25. The dike construction was completed in 1942 and the Lake was then divided into three management units - the North, Center, and South. Owens Bay had its own dike and was owned in fee title and is dealt with separately from Lake Andes. The average depths for the three individual units in 1962 were 9.1, 12.9, and 11.5 feet, respectively.

In 1976, the SCS conducted a study to determine if there were any significant effects produced by the stock dams and dugouts on the drainage area of Lake Andes. It was found that, as of 1976, there were 393 dams and dugouts in the Lake Andes drainage area. These dams and dugouts were capable of holding back less than one inch of surface water over the entire lake surface (Decker, 1982).

The water supply for this lake comes almost entirely from watershed run-off. A very minor source of water which periodically drains into Owens Bay is an artesian well. The amount of precipitation during one year can have a dramatic effect on the water level of Lake Andes. The water management plan at Lake Andes in 1980 was concerned with holding as much water as possible in the lake with no manipulation between units (Lake Andes NWR Annual Water Management Plan, 1980). This plan was the direct result of three factors:

1) there usually was not enough water to manipulate,
2) local citizens wanted recreation on the lake, and
3) the periodic dry-wet cycles provided maximum invertebrate production for use by waterfowl.

The result of this management scheme was the North Unit must fill before water spills into the Center Unit, which in turn must fill before the South Unit. The North Unit is usually the only unit with enough water to hold game fish (Decker, 1982).

Artesian Wells

There have been several attempts at maintaining the water level within the lake. An additional attempt at maintaining the water level was made by the construction of artesian wells. Several wells have been drilled within the confines of the shore. Most have either been plugged, are non-functional, or simply have never produced water. In any case, there still is a functional well found on the wildlife refuge. This well, in the absence of runoff, does not produce enough water to maintain the waterlevel within Owens Bay.

Fisheries Management Problems

Prior to 1978, Lake Andes had been nearly dry for several years and fish management activities were suspended. However, during the winter and spring of 1977-78 enough runoff occurred to fill the North Unit and make it suitable to sustain game fish. Fathead minnows and northern pike fry were stocked in the spring of 1978; later that summer a few yellow perch, bluegill, and largemouth bass were added. Fish were sampled once in 1979 and once in 1980; data indicated that black bullheads and yellow perch dominated the fishery. In 1980, the population biomass was dominated by black bullheads and northern pike. Limited numbers of the largemouth and bluegill stocked the previous year were caught. Because of the low water and the right conditions for a summerkill, the scheduled fish stocking of northern pike and largemouth bass for 1980 was cancelled. As a result of the fluctuating waterlevels within this lake, winterkill and summerkill events are common place and greatly influence the fish population dynamics of this lake. A fisheries management plan was attempted by estimating the relationship between fish kills, lake depth, and probability that the lake will be at these depths in any given year. Through this procedure it was found that 65 percent of the time the North Unit will have an August maximum depth of 6 feet. However, this was only a hypothesis and is based on incomplete data. The recommendations for the management plan in 1980 were that no further fish stocking should take place unless the lake fills (USFWS, 1980).

The U.S. Fish and Wildlife's management progress report for the Lake Andes fishery in 1989 indicated that bullheads and carp were a problem again. These fish have been a continual problem and must be dealt with each year as they cannot be prevented from entering the lake. According to the progress report, 1990 was a very critical year for the lake because the strong year class of bluegills found within the south unit may have trouble reproducing as a result of the increased numbers of bullheads (USFWS, 1990).

Waterfowl Population Monitoring

The waterfowl population for Lake Andes has been well-documented as a result of the formation of the Lake Andes National Wildlife Refuge in 1936. The executive order which established the refuge identified 365 acres of fee title land around Owens Bay to be set apart as a refuge and breeding ground for migratory birds and other wildlife. In 1939, the State of South Dakota granted a perpetual easement to the U.S. fish & Wildlife Service for the management of Lake Andes. The lands covered in the easement are "... all lands lying within the ordinary high water mark of the navigable meandered lake." The duck and goose population found within the refuge during the spring and fall migration periods can reach numbers well into the thousands. The water quality of this refuge facility may be effected by these large numbers of waterfowl. On the average, 1000 ducks weighing 4 lbs a piece can produce 1.42 lbs of total nitrogen, 0.62 lbs of total phosphorus, and 24 lbs of suspended solids per day along with other chemical parameters in small amounts (SCS, 1978). Table 1 shows the waterfowl use of Lake Andes for three years taken from surveys conducted by the USFWS and SDGF&P.

Table 1 . Waterfowl Survey Numbers from Lake Andes

YEAR	UNIT	GOOSE #'S	DUCK #'S
1990	NORTH	34,138	43,797
	CENTER	41,350	24,060
	SOUTH	22,399	117,248
	OWEN'S BAY	26,306	75,403
	*LAKE ANDES	1,700	27,000
1991	NORTH	1,925	13,773
	CENTER	33,785	15,057
	SOUTH	6,113	8,523
	OWEN'S BAY	46,279	29,392
	*LAKE ANDES	5,820	28,900
1992	NORTH	5,140	9,359
	CENTER	1,577	4,721
	SOUTH	250	2,498
	OWEN'S BAY	8,003	18,751

* FROM SDGF&P AERIAL SURVEYS.

Selenium Concerns

Selenium has been found in certain concentrations within the area of the proposed irrigation project which includes a small portion of the Lake Andes watershed. A preliminary toxic element investigation was completed in order to determine the concentration levels of selenium within the area of the proposed

Lake Andes-Wagner/Marty II project. According to this investigation the total selenium in both till and non-till sediments appeared to be an order of magnitude higher than the drinking water standard of 50 ppb in 1990. It also concluded that the concentration levels were highly variable and extremely unpredictable within the confines of till and non-till sediments. Selenium, when taken internally in amounts exceeding this level of concentration, can cause severe physiological problems involving the gastrointestinal system (Bureau of Reclamation, 1990).

METHODS AND MATERIALS

Water quality monitoring was the method that was used to determine the sediment and nutrient problems with Lake Andes and its watershed. The concentration of several physical and chemical parameters can be incorporated with the flow rates from selected tributaries to yield a hydrologic budget. This method can be very useful in identifying areas of high nutrient input but not without excessive cost or time.

Water Quality Monitoring

Tributaries

The outlet and six inlets that were selected as tributary sampling sites for the Lake Andes Watershed are described below and can be found on Figure 3.

Site 1. Andes Creek, located at the north end of Lake Andes and entering the lake at SW1/4, SW1/4, S3, T97N, R64W.

Site 2. North Refuge Tributary, located approximately 1 mile southwest of the northern Lake Andes National Wildlife Refuge and entering Lake Andes at E1/2, E1/2, S17, T97N, R64W.

Site 3. Northwest Tributary A, entering lake Andes at NE1/4, S20, T97N, R64W.

Site 4. Northwest Tributary B, entering Lake Andes at NE1/4, S31, T97N, R64W.

Site 5. Dezera Tributary, located approximately 1/4 mile west of Dezera and entering Lake Andes at NE1/4, S3, T96N, R65W.

Site 6. Lake Andes Outlet, located approximately 1/4 mile southeast of the town of Lake Andes and dischargi from the lake at E1/2, NE1.4, S9, T96N, R65W.

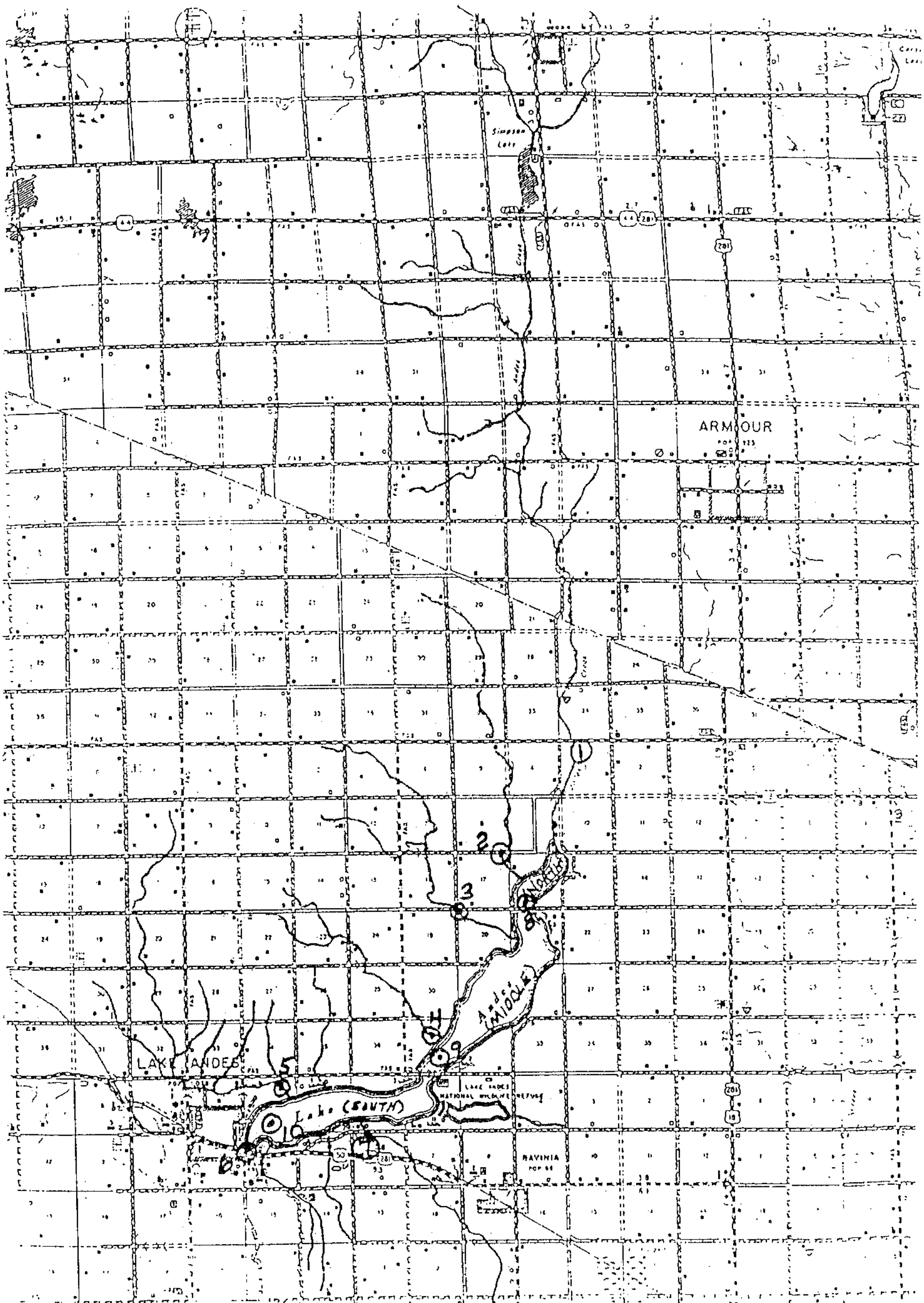


Figure 3. Lake Andes Water Quality Monitoring Sites.

Site 7. South Refuge Tributary, located approximately 1 mile west of the southern end of the Lake Andes National Wildlife refuge and entering Lake Andes at SW1/4, S1, T96N, R65W.

Sampling was modified according to flow volume at each site, samples were to be taken when the tributaries flowed. All sites were to be sampled, if possible, twice week during the first week of snowmelt runoff and once a week there-after until runoff was completed. Samples were to be collected daily during any runoff producing storm events. Stage recorders were placed at sites 1, 3, 5, 6, and 7 to monitor periods of peak runoff and any time subsequent to this period. Current velocity was to be monitored at these sites to determine total flows and stage/discharge.

Inlake Sampling

Three inlake sampling sites were selected for Lake Andes (Figure 3) and are described as follows:

Site 8. North inlake site, located approximately 1/4 mile north of the midpoint of sections 16 and 21, T97N, R64W.

Site 9. Middle inlake site, located approximately 1/4 mile north of the midpoint of sections 31 (T96N, R64W) and section 6 (T97N, R64W).

Site 10. South inlake site, located approximately 1/4 mile east of the town of Lake Andes.

Sampling took place monthly from October through March and twice a month from April through September. The lake itself was very shallow and most of the sampling was done by wading to the site and retrieving a grab sample approximately 0.5 feet below the surface.

The sampling period for the study extended from November 13, 1990 through May 29, 1992. During this period, a total of 75 samples were collected from the 10 sites.

Table 2. Sampling Period and Number of Samples

SITE #	SAMPLING PERIOD FROM:		TO:	# OF SAMPLES
1			5/29/91	1
2				0
3				0
4				0
5			5/29/91	1
6				0
7			5/29/91	1
8	11/13/90	-	5/27/92	24
9	11/13/90	-	5/27/92	24
10	11/13/90	-	5/27/92	24
			Total Samples	75

Drought conditions prevailed throughout the entire time period that the phase I study was in progress. As a result, sampling was not possible from sites 2, 3, 4 or 6. The other tributary sites received minimal runoff events and were sampled whenever possible. The in-lake sites under normal conditions would have samples collected at the surface and at the bottom of the lake, however, because of the shallow depth of Lake Andes, only surface samples were taken.

The laboratory analysis was conducted by the South Dakota State Health Laboratory in Pierre, South Dakota. Field sample collection and analyses were conducted by Jim VonEschen, a local resident.

The raw data were compiled by the South Dakota Department of Environment and Natural Resources, Division of Water Resources Management. Water quality parameters were loaded into the computer and analyzed.

The water quality parameters that were tested at all of the sampling sites are shown in Table 3. A description of each parameter may be found in Appendix C.

Table 3. Water Quality Parameters

Parameters	
Water Temperature	Total Solids
Air Temperature	Total Dissolved Solids
Secchi Disk	Total Suspended Solids
Dissolved Oxygen	Ammonia
Field pH	Nitrates & Nitrites
Fecal Coliform Bacteria	Total Kjeldahl Nitrogen
Laboratory pH	Total Phosphorus
Total Alkalinity	Orthophosphate
Unionized Ammonia	

WATER QUALITY STANDARDS

The surface water quality standards for the State of South Dakota are based on the highest ranking beneficial use assigned to a body of water. The highest beneficial use assigned to Lake Andes is warmwater marginal fish propagation. Other beneficial uses assigned to Lake Andes are immersion recreation, limited contact recreation, and wildlife propagation and stock watering. The water quality standards for Lake Andes are listed in Table 4.

Table 4. Lake Andes Water Quality Standards

Parameter	Standard
Total Chlorine Residual	<0.02 mg/L*
Un-Ionized Ammonia Nitrogen	<0.05 mg/l*
Total Cyanide	<0.02 mg/L
Free Cyanide	<0.005 mg/L
Dissolved Oxygen	>4.0 mg/L
Undisassociated Hydrogen Sulfide	<0.002 mg/L
pH	>6.5 & <8.3 units
Suspended Solids	<150 mg/L*
Temperature	<90° F
Polychlorinated Biphenyls	<0.000001 mg/L
Fecal Coliform Organisms	<200 per 100 ml**
Total Alkalinity	<750 mg/L*
Total Dissolved Solids	<2500 mg/L*
Conductivity	<400 micromhos/cm*
Nitrates	<50 mg/L*

* The applicable criterion is to be maintained at all times based upon the results of a 24-hour representative composite sample. The numerical value of a parameter found in any one grab sample collected during the period may not exceed 1.75 times the applicable criterion.

** Fecal coliform organisms from May 1 to September 30 may not exceed a concentration of 200 per 100 ml as a geometric mean based on a minimum of 5 samples obtained during separate 24 hour periods for any 30-day period, and they exceed this value only 20% of the samples examined in this 30-day period. They may not exceed 400/100 ml in any one sample from May 1 to September 30.

The water supply for the lake is entirely dependent upon precipitation and snow melt; there are no permanent streams to the lake. Of the several intermittent streams that discharge into the Lake, Andes Creek is the most important. This creek begins a few miles northwest of Corsica in Douglas County and continues south discharging into the north unit of Lake Andes. The beneficial uses assigned to this and the other tributaries of Lake Andes are wildlife propagation and stock watering and irrigation waters. The water quality standards for these tributaries are listed in Table 5.

Table 5. Lake Andes Tributary Water Quality Standards

Parameter	Standard
Total Alkalinity	<750 mg/L*
Total Dissolved Solids	<2500 mg/L*
Conductivity	<2500 micromhos/cm*
Nitrates	<50 mg/L*
pH	>6.0 & <9.5 units
Sodium Absorption Ratio	<10:1*

* The applicable criterion is to be maintained at all times based upon the results of a 24-hour representative composite sample. the numerical value of a parameter found in any one grab sample collected during the period may not exceed 1.75 times the applicable criterion.

RESULTS AND DISCUSSION OF WATER QUALITY MONITORING

IN-LAKE

The data analysis of the chemical parameters of all three in-lake sites indicate a lake in a hypereutrophic condition. The water quality standards adopted by the state of South Dakota were exceeded in several cases. The total nitrogen and total phosphorus parameters are not subject to these standards but are very important relative to the water quality of a lake. The parameters that are discussed below were chosen because they exceeded their standards at least once throughout the course of the study and are responsible for limitations on assigned uses. Table 6 contains all the in-lake data for the three in-lake sites. Graphs comparing the three in-lake sites can be found in Appendix C.

An important component which may have had a significant effect on the water quality of Lake Andes is stagnation. Lake levels have declined with no significant amounts of runoff and with no influx of water the lake became stagnate. This phenomena may result in and may be caused in part by anoxic conditions and increased pH and temperature. These conditions create a suitable situation in which phosphorus and other trace elements bound to the sediments can be transferred to the water column. This action can then cause algae blooms, summerkill events, and cause the state standards that were described previously to be exceeded.

Dissolved Oxygen

There were several samples throughout the investigation in which the concentrations of dissolved oxygen were found to be far lower than the set standard of 4.0 mg/L. All three sites exhibited similar levels throughout the course of the study. The lowest level of dissolved oxygen was 0.13 mg/L which was recorded at site 9 on May 27, 1992 (Table 6). Lake Andes was very shallow and the extremely low oxygen levels can be attributed to plant and animal respiration as well as bacterial decomposition of organic matter. As the oxygen levels decline near the sediment interface, phosphorus and other nutrients have a higher potential to be released from the sediments into the water column (Wetzel, 1983). This process, termed internal loading, can cause many water quality problems and may have a negative impact on the beneficial use of the lake. Low oxygen levels are also responsible for fish kills. Most game fish cannot survive in water where oxygen levels are lower than 3.5 mg/L (Cole, 1983). In this case with decreased oxygen levels we can expect to have an increase in the amount of phosphorus found within the water samples.

Fecal Coliform Bacteria

Fecal coliform bacteria inhabit the digestive systems of warm-blooded animals. The presence of fecal coliform bacteria in water is evidence of human or animal waste in the water supply. Sources for these organisms include wild mammals and domestic livestock near the lake or in the watershed, or failing/insufficient sewage systems. High concentrations of these bacterial organisms generally coincide with high concentrations of nutrients such as phosphorus and nitrogen. High fecal coliform bacteria concentrations also create a high oxygen demand, resulting in a lower levels of dissolved oxygen which support aquatic life (MPCA). One sample taken on September 24, 1991, had a count of 420 organisms per 100 ml. This was taken at site 8 on the north unit. There was only one other sample with a fairly high count of 130 organisms per 100 ml. The state standard listed for the highest beneficial use is considered to be 200 organisms per 100 ml. These were the only samples which exhibited any type of an increase in the numbers of these organisms. This suggests that there was no fecal problem within the lake during the course of the study.

pH

The pH standard for Lake Andes from Table 4 is >6.3 & <8.3 units. Of the 72 samples that were taken, 50 exceeded the 8.3 standard. The pH was analyzed again during the State Health Laboratory's examination. Of the 72 samples analyzed 45 exceeded the state standard (Table 6). There were approximately an equal number of samples from each of the three in-lake sites which exceeded this standard. This indicated that the conditions causing the increase in pH levels were prevalent throughout the lake. The causes for this increase in pH are dependent upon many factors including the hardness of the water, temperature, photosynthesis and decomposition. Hard waters act as a buffer to pH, however, photosynthesis may counteract the buffer and be responsible for high pH levels (Vallentyne, 1974). Stagnation, as previously discussed, may have caused the lake to slightly increase in pH as well.

Un-ionized Ammonia

Un-ionized ammonia is a calculated fraction of total ammonia. The accumulation of ammonia greatly accelerates as the hypolimnion becomes anoxic. Under anaerobic conditions, bacterial nitrification of ammonia to nitrate and nitrite ceases as the redox potential is reduced to below about +0.4 volts. With anoxic conditions prevailing the adsorptive capacity of the sediments is greatly reduced. A marked release of ammonia from the sediment then occurs. With an increase in pH and temperature you can expect the concentration for un-ionized ammonia to increase. The standard for this parameter is 0.0875 mg/L (1.75 times 0.05 mg/L) for a single grab sample. Throughout the course of the study the standard was surpassed 14 times with the highest value of 0.36 mg/L occuring site at 9. With a reduction in the temperature and pH this parameter should also decrease in concentration. This parameter is highly toxic to many organisms, especially fish.

Phosphorus

Although a state standard for this nutrient has not been implemented by this state, this nutrient should not be ignored. It is an element which is very important for the production of algae and macrophytes as well as other biological organisms. When a lake is subjected to anoxic conditions, phosphorus may be released from the sediments. After analysis, the in-lake samples revealed minimum and maximum concentrations of 0.081 mg/L and 2.16 mg/L, respectively. The average concentrations for each of the three in-lake sites were: site 8 = 0.764 mg/L; site 9 = 0.692 mg/L; site 10 = 0.807 mg/L. Lake Andes, even though stagnate, is still considered a hypereutrophic lake. This means that the high concentrations of nutrients will cause nuisance algae blooms. Optimum conditions for a nuisance algae bloom to occur require minimum concentrations of 0.02 mg/L (Wetzel, 1983). The minimum concentration of any of the three in-lake sites was 0.081 mg/L exceeding the necessary amount for an algae bloom to occur. The more common sources of phosphorus in a lake are known to be animal or human waste, fertilizers, detergents, run off from land (sediments), internal loading from the sediments, and biodegradation of macrophytes and other biological organisms.

Limiting Nutrient

The limiting nutrient concept states that the production of algae will be determined by the least abundant substance needed for survival in the environment. According to the concept, if you

Lake Andes In-Lake Sample Data 1991-1992

ECT	DATE	TIME	SITE	SAMP	DEPT	WTEMP C	ATEMP C	SECCH Feet	DISOX mg/L	FPH su	FECAL /100 m	LABP su	TALKA mg/L	TSOL mg/L	TDSOL mg/L	TSSO mg/L	VOLA SOLID mg/L	FIXED SOLID mg/L	AMMO mg/L	UNIONIZ AMMONI mg/l	PERCENT UNIONIZ	PKA	NO3+ mg/L	TKN-N mg/L	TPO4P mg/L	TOTAL DISS. PO4P mg/L
WOES	13-Nov-90	1030	8	GRAB	SURF	4.4	6.7	0.9	9.8	8.6	10	8.4	156	4704	4644	60	NA	NA	0.05	0.00226	4.525649	9.22	0.1	4.33	0.596	NA
WOES	08-Jan-91	1100	8	GRAB	SURF	-1.1	-12.2	NA	3.8	6.8	10	7.3	396	11552	11468	84	NA	NA	1.43	0.00068	0.047515	10.12	0.1	6.03	0.868	NA
WOES	12-Feb-91	930	8	GRAB	SURF	-1.1	0	0.61	7.8	7.1	10	7.66	196	5497	5467	30	NA	NA	1.29	0.00122	0.09478	10.12	0.1	6.61	0.691	NA
WOES	19-Mar-91	1030	8	GRAB	SURF	4.4	10	0.4572	11.2	8.6	2	8.7	163	3535	3451	84	52	32	0.08	0.00362	4.525649	9.92	0.1	5.04	0.746	0.312
WOES	10-Apr-91	1115	8	GRAB	SURF	7.2	3.3	0.5	12.5	8.4	10	8.48	115	4673	4509	164	70	94	0.1	0.00361	3.614319	9.83	0.1	4.6	1.49	0.203
WOES	23-Apr-91	1030	8	GRAB	SURF	7.7	6.7	0.5	8.2	8.4	8	7.57	137	4602	4462	140	32	108	0.07	0.00263	3.755931	9.81	0.1	3.98	1.18	0.264
WOES	07-May-91	1015	8	GRAB	SURF	10	10	0.67	9.3	8.5	30	8.88	13.3	4715	4653	62	26	36	0.05	0.00278	5.564271	9.73	0.1	4.63	0.915	0.19
WOES	22-May-91	900	8	GRAB	SURF	21	23	0.5	5.2	8.2	20	8.31	140	5241	5149	92	40	52	0.08	0.00607	8.34212	9.37	0.1	5.46	1.17	0.244
WOES	04-Jun-91	1045	8	GRAB	SURF	23	22	0.5	4	8.4	130	8.33	155	4389	4293	96	12	84	0.08	0.00882	11.03029	9.31	0.1	6.02	1.48	0.475
WOES	18-Jun-91	900	8	GRAB	SURF	24.6	23	0.5	8.4	9.3	80	9.37	136	2932	2860	72	60	12	0.12	0.06275	62.2665	9.26	0.6	9.01	1.34	0.264
WOES	02-Jul-91	1100	8	GRAB	SURF	23	27	1	9.4	9.1	10	9.33	58.8	3042	2996	46	42	4	0.05	0.01916	38.32346	9.31	0.6	4.65	0.461	0.115
WOES	17-Jul-91	1100	8	GRAB	SURF	26.5	27.8	0.5	8.3	9.2	10	9.06	52	3460	3374	86	32	54	0.04	0.01932	48.30151	9.23	0.5	7.17	0.597	0.142
WOES	01-Aug-91	1045	8	GRAB	SURF	25.6	26.7	0.5	7	8.9	10	8.7	42.8	3650	3546	104	42	62	0.04	0.01275	31.89196	9.23	0.4	6.15	0.664	0.19
WOES	15-Aug-91	940	8	GRAB	SURF	22.2	26	0.5	6.2	8.5	10	8.28	88.2	3798	3698	100	38	62	0.62	0.07963	12.84363	9.33	0.7	7.65	0.515	0.081
WOES	29-Aug-91	900	8	GRAB	SURF	22.8	26.7	0.5	3.4	8.2	10	7.29	83	4052	3956	96	56	40	1.21	0.08662	7.159073	9.31	0.1	7.66	0.644	0.163
WOES	12-Sep-91	915	8	GRAB	SURF	21	20	0.5	3.2	8.3	30	8.38	72.8	4151	4023	128	52	76	0.41	0.03221	7.856262	9.37	0.1	0.63	0.661	0.074
WOES	24-Sep-91	1030	8	GRAB	SURF	10.5	15.6	0.5	10	9.1	10	8.71	73	3958	3842	116	72	44	0.53	0.10393	19.60947	9.71	0.1	6.9	0.617	0.163
WOES	18-Dec-91	1100	8	GRAB	SURF	0	-6.7	1	15	7.5	10	8.04	118	4508	4482	26	20	6	1.27	0.00331	0.260795	10.08	0.1	6	0.216	0.09
WOES	28-Jan-92	1030	8	GRAB	SURF	-0.5	0.5	1.5	15	8.4	10	8.89	104	4202	4153	49	24	25	0.83	0.01620	1.952314	10.10	0.2	5.09	0.256	0.073
WOES	27-Feb-92	930	8	GRAB	SURF	2.78	5.556	0.5	9.6	8.8	10	7.98	163	3788	3360	428	100	328	1.57	0.09690	6.171937	9.98	0.2	6.27	0.168	0.146
WOES	07-Apr-92	845	8	GRAB	SURF	8.96	9.52	0.5	8	8.3	20	8.5	109	4409	4299	110	30	80	0.02	0.00066	3.312179	9.77	0.1	4.63	1.182	0.232
WOES	28-Apr-92	915	8	GRAB	SURF	10.1	11.2	0.5	8.3	8.3	10	8.49	86.6	3770	3684	86	56	30	0.02	0.00072	3.611598	9.73	0.1	6	0.468	0.053
WOES	13-May-92	740	8	GRAB	SURF	11.2	9.5	0.5	2.5	8.6	20	7.48	192	6389	6141	246	52	196	0.11	0.00829	7.532422	9.69	0.1	5.63	0.359	0.299
WOES	27-May-92	815	8	GRAB	SURF	8.96	10.1	0.5	4.2	8.3	50	7.65	281	8047	7941	106	24	82	5.49	0.16184	3.312179	9.77	0.1	14.52	0.896	0.396

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ECT	DATE	TIME	SITE	SAMP	DEPT	WTEMP C	ATEMP C	SECCH Feet	DISOX mg/L	FPH su	FECAL /100 m	LABP su	TALKA mg/L
NDES	13-Nov-90	1205	9	GRAB	SURF	3.9	5	0.8	9.2	8.6	10	8.71	102
NDES	08-Jan-91	1200	9	GRAB	SURF	-0.5	-12.2	NA	5.4	7.1	10	7.82	197
NDES	12-Feb-91	1100	9	GRAB	SURF	-0.6	4.4	0.61	5.5	7.2	10	8.12	25.2
NDES	19-Mar-91	1130	9	GRAB	SURF	5.6	14.4	0.51	12.5	8.8	2	8.8	111
NDES	10-Apr-91	1220	9	GRAB	SURF	9.4	15.6	1	10.2	8.6	10	8.59	100
NDES	23-Apr-91	1130	9	GRAB	SURF	9.4	8.9	1	9.2	9	4	8.31	105
NDES	07-May-91	1100	9	GRAB	SURF	9.4	5.6	0.67	9.6	8.8	10	8.46	108
NDES	22-May-91	945	9	GRAB	SURF	21	24	1	7.4	8.5	10	8.23	119
NDES	04-Jun-91	1245	9	GRAB	SURF	23	24.5	0.67	4.5	7.2	10	7.85	107
NDES	19-Jun-91	1000	9	GRAB	SURF	21.6	27	0.5	6.8	8.7	10	8.58	104
NDES	02-Jul-91	1020	9	GRAB	SURF	22	25.5	0.5	6.6	8.9	10	9.09	90.8
NDES	17-Jul-91	1000	9	GRAB	SURF	25.5	29.4	0.5	6.4	8.6	10	8.26	75.4
NDES	01-Aug-91	1015	9	GRAB	SURF	26	26.7	0.5	5.1	8.8	10	8.9	59.2
NDES	15-Aug-91	1015	9	GRAB	SURF	22.2	25.5	0.5	3.6	8.8	10	8.6	97
NDES	29-Aug-91	845	9	GRAB	SURF	23.3	26.7	0.5	2.4	8.6	20	7.16	93
NDES	12-Sep-91	845	9	GRAB	SURF	22	20	0.5	4.2	8.4	20	8.41	90.4
NDES	24-Sep-91	1000	9	GRAB	SURF	8.9	11.1	0.5	9.6	8.7	70	8.02	107
NDES	17-Dec-91	1115	9	GRAB	SURF	0	-6.7	0.17	14	8.3	10	7.79	186
NDES	28-Jan-92	1000	9	GRAB	SURF	-0.5	0	1.5	15	8	10	8.31	327
NDES	27-Feb-92	945	9	GRAB	SURF	3.33	8.1	0.5	11.2	8.5	10	8.37	119
NDES	07-Apr-92	915	9	GRAB	SURF	10.6	8.96	0.5	10.8	8.6	10	8.44	86.6
NDES	28-Apr-92	1000	9	GRAB	SURF	11.8	12.3	0.5	8.3	8.8	10	8.75	95.2
NDES	13-May-92	815	9	GRAB	SURF	12.3	10.1	0.5	5	8.3	30	7.39	113
NDES	27-May-92	830	9	GRAB	SURF	12.3	14.6	0.33	0.13	8.6	10	8.02	162

DATE	TSOL mg/L	TDSOL mg/L	TSSO mg/L	VOLA SOLID mg/L	FIXED SOLID mg/L	AMMO mg/L	UNIONIZ AMMONI mg/l	PERCENT UNIONIZ	PKA	NO3+ mg/L	TKN-N mg/L	TPO4P mg/L	TOTAL DISS. PO4P mg/L
13-Nov-90	2554	2486	68	NA	NA	0.36	0.01567	4.352544	9.94	0.1	3.92	0.434	NA
08-Jan-91	3822	3784	38	NA	NA	1.78	0.00177	0.099696	10.10	0.1	6.99	0.441	NA
12-Feb-91	388	384	4	NA	NA	0.28	0.00035	0.125478	10.10	0.1	1.2	0.081	NA
19-Mar-91	2561	2469	92	52	40	0.05	0.00382	7.646647	9.88	0.1	4.66	0.603	0.102
10-Apr-91	2670	2618	52	26	26	0.07	0.00463	6.609646	9.75	0.1	3.51	0.441	0.166
23-Apr-91	2694	2628	66	36	30	0.05	0.00755	15.09223	9.75	0.1		0.447	0.086
07-May-91	2873	2821	52	40	12	0.03	0.00303	10.08421	9.75	0.1	4.08	0.434	0.066
22-May-91	2808	2770	38	24	14	0.04	0.00478	11.90266	9.37	0.1	3.94	0.434	0.068
04-Jun-91	2630	2550	80	22	28	0.3	0.00233	0.776177	9.31	0.1	6.01	0.615	0.076
19-Jun-91	2886	2858	28	24	4	0.1	0.01817	18.1697	9.36	0.8	6.44	0.69	0.116
02-Jul-91	3079	3025	54	34	20	0.1	0.02673	26.73229	9.34	0.8	5.67	0.766	0.102
17-Jul-91	3533	3421	112	48	64	0.08	0.01267	16.71262	9.23	0.5	9.45	1.017	0.17
01-Aug-91	3790	3642	148	72	76	0.05	0.01391	27.81147	9.21	0.5	9.39	0.929	0.244
15-Aug-91	3969	3775	184	96	88	0.25	0.05680	22.72176	9.33	0.7	9.25	0.908	0.142
29-Aug-91	4548	4404	144	100	44	1.57	0.26249	16.71918	9.30	0.1	18.44	1.105	0.17
12-Sep-91	4790	4638	152	92	60	3.46	0.35791	10.34431	9.34	0.1	11.6	1.085	0.17
24-Sep-91	4658	4478	180	120	60	4.27	0.33684	7.888851	9.77	0.1	12.1	1.173	0.286
17-Dec-91	6724	5690	34	20	14	1.81	0.02936	1.622031	10.08	0.1	8.2	0.398	0.1
28-Jan-92	5564	5510	54	32	22	2.85	0.02241	0.786472	10.10	0.1	9.07	0.312	0.098
27-Feb-92	4242	4132	110	62	48	1.27	0.04235	3.334626	9.96	0.1	7.62	0.129	0.093
07-Apr-92	4467	4307	160	100	60	0.03	0.00218	7.213361	9.71	0.1	6.99	1.109	0.166
28-Apr-92	4396	4132	264	124	140	0.02	0.00238	11.91406	9.67	0.1	8.65	0.988	0.179
13-May-92	6138	5010	128	64	64	0.11	0.00466	4.236362	9.65	0.1	6.37	0.946	0.232
27-May-92	6050	5362	668	196	472	0.03	0.00244	8.147417	9.66	0.1	7.39	1.078	0.113

ributary Sample Data for Lake Andes 1991-1992

ECT	DATE	TIME	SITE	SAMP	DEPT	WTEMP C	ATEMP C	SECCH Feet	DISOX mg/L	FPH su	FECAL /100 m	LABP su	TALKAL mg/L	TSOL mg/L	TDSOL mg/L	TSSO mg/L	VOLAT SOLID mg/L	FIXED SOLIDS mg/L	AMMO mg/L	NO3 mg/L	TKN-N mg/L	TPO4P mg/L	TOTAL DIS. PO4P mg/L
NDES	29-May-91	930	1	GRAB	SURF	20	21	0.6	7.6	8	4800	7.3	117	785	677	108	36	72	0.04	0.9	1.61	0.725	0.454

ECT	DATE	TIME	SITE	SAMP	DEPT	WTEMP C	ATEMP C	SECCH Feet	DISOX mg/L	FPH su	FECAL /100 m	LABP su	TALKAL mg/L	TSOL mg/L	TDSOL mg/L	TSSO mg/L	VOLAT SOLID mg/L	FIXED SOLIDS mg/L	AMMO mg/L	NO3 mg/L	TKN-N mg/L	TPO4P mg/L	TOTAL DIS. PO4P mg/L
NDES	29-May-91	1100	6	GRAB	SURF	22	21	1	5.8	7.5	56000	7.39	102	1847	547	1300	216	1084	0.19	0.7	3.62	1.55	0.434

ECT	DATE	TIME	SITE	SAMP	DEPT	WTEMP C	ATEMP C	SECCH Feet	DISOX mg/L	FPH su	FECAL /100 m	LABP su	TALKAL mg/L	TSOL mg/L	TDSOL mg/L	TSSO mg/L	VOLAT SOLID mg/L	FIXED SOLIDS mg/L	AMMO mg/L	NO3 mg/L	TKN-N mg/L	TPO4P mg/L	TOTAL DIS. PO4P mg/L
NDES	29-May-91	1230	7	GRAB	SURF	21	23	0.33	8	7.7	22000	7.36	133	3754	0	3754	300	3454	0.22	2.5	1.89	1.17	0.732

control the limiting nutrient for algae, you can control the production of the organism and thus it's rate of growth (Wetzel, 1983). The applicability of this theory to the Lake Andes situation is somewhat decreased as a result of the stagnating lake water. Throughout the course of the investigation the concentrations of both phosphorus and nitrogen were very high as was discussed.

TRIBUTARY

To determine specific problem areas associated with non-point source pollution, tributary sites were established within the watershed of Lake Andes. The information gathered from these monitoring sites would have also been used in the development of a hydrologic budget to estimate nutrient loads to the lake. During the 20 month sampling period there was only one runoff occurrence in which inflow data was gained. No outflow occurred. As a result, a hydrologic budget could not be calculated and an estimation of the nutrient loadings could not be made. Although no tributary water samples were analyzed, the United States Geological Survey has several years of water quality data taken from the same or near the original tributary sites as well as the in-lake sites. There were high amounts of total phosphorus in all of the sites sampled by the USGS from both in-lake and the tributaries exceeding the amount required for a nuisance algae bloom. At most of the USGS sampling sites there were higher than state standard concentrations of unionized ammonia. The parameters tested for by the USGS on the tributary sites were essentially the same as those that were tested for during the present study. The tabular data for the USGS monitoring sites can be found in Appendix D.

A site by site analysis of the tributaries for the Lake Andes watershed was not feasible due to the existing drought conditions. As stated earlier, the tributary sites for Lake Andes conform to a moderately different set of state standards because of their beneficial use classification. One runoff event did occur during the study period and was recorded at sites 1, 5, and 7. The water samples taken during this May 29, 1991 occurrence were found to have extremely high fecal counts (maximum number of 55,000 was recorded at site 5). These high fecal counts may be a result of a first flush occurrence and it is difficult to determine if there is a problem with this organism from only one runoff event.

CONCLUSIONS

Cole states in his textbook of limnology that "Natural lakes arise from phenomena that are almost entirely geologic in nature. Once formed, they are doomed. Because of the concave nature of basins, there is a compulsory trend toward obliteration as they fill with sediment." Lake Andes is succumbing to the fate that eventually falls upon all lakes. With implementation of the culvert in the 1930's which decreased the lake levels by 13 feet (Decker, 82) there was a trend for the lake to go dry approximately every eleven years. Lake Andes has a fairly small watershed relative to the lake size which does not provide adequate water during drought. Nutrients have caused a continual decline in the water quality of this lake. The shallowness of Lake Andes also encourages macrophyte growth, which with summer- and winterkill events, make it a very difficult fishery to manage.

During wet years, the high amounts of nutrients make Lake Andes a very productive lake. The past results of this high productivity can be seen in the history of the lake recorded in terms of bass fishing. However, with the increase of bullheads and carp, this fishery gradually declines. The lake at lower water levels is used by waterfowl during migration periods, and as a significant waterfowl production area.

The data gained in the present study plus the historical information that was available indicated that there are problems with eutrophication. Before restoration of Lake Andes is attempted the watershed improvement plans should be implemented.

It must be noted that even if everything possible is done to correct the problems in the watershed, Lake Andes will probably remain eutrophic to hypereutrophic. Benefits received by the alternatives listed below will shorten the duration and intensities of algae blooms, control some of the macrophyte problem, and if bullhead and carp problems are dealt with consistently may improve the fishery.

RESTORATION ALTERNATIVES

There are several alternatives available for the restoration of Lake Andes. These alternatives listed below were chosen on the basis of effectiveness, cost, and their probability of success:

1. No Action
2. Selective Dredging
3. Land based removal of sediment
4. Dilution/Flushing

No Action

If no action is taken to restore the quality of Lake Andes and its watershed, problems will continue and may become more serious. Sediment buildup will continue and depth will decrease until the lake is a wetland or marsh which could only be used by waterfowl. The fishery would continually be in a state flux as result of the high rate winterkill and summerkill events and the inability to prevent the infestation of rough species of fish.

These stressful conditions will result in a poor fishery dominated by bullheads and carp rather than the more popular game fish such as northern pike and largemouth bass. Minimal outflow events would occur and nutrients would continue to cycle throughout the ecosystem of the lake. The lake would become a wetland with limited contact recreational value. Benefits associated with this type of situation would be improved hunting, perhaps hiking and camping, and increased habitat for wildlife.

Selective Dredging

If dredging selected areas on the south unit of the lake is chosen a sediment survey must be completed prior to dredging. This survey is usually completed during a phase I study but due to the mild winter and thin ice a sediment survey could not be accomplished. It is necessary to have some estimation of the volume and distribution of the sediment within the south unit. Before any major dredging is undertaken, the rate of sedimentation should also be determined. It is of little value to dredge a reservoir that is filling in at a rate of 2 inches or more a year if watershed controls for erosion are not implemented. Sediment removal to retard nutrient release can be highly effective. Certain areas where dredging takes place may provide significant habitat for fish and other living organisms especially during fishkill events. It will also remove some of the nutrient-rich sediments. The water may become somewhat clearer because the deeper depths will limit the wave action suspending solids in the water column. Selective dredging is less expensive and less time consuming than whole lake dredging. Areas not dredged will still have a macrophyte problem. The total amount of sediment and the location of the greatest sediment concentrations would still need to be calculated. The average operational cost of an eight inch dredge for a year is $175,000, not including start-up costs of approximately $75,000.

A limited alum treatment along with selective dredging may reduce the amount of internal loading of phosphorus from the sediments. However, this may not be effective if only the south unit is treated. Temperature and pH will have to be closely monitored to determine if this is feasible.

Land Based Removal of Sediment

This method may be the most feasible since Lake Andes has a high tendency to go dry approximately once every twenty years. It may be in the best interest of this project to use land-based equipment to remove the sediment if this event takes place in the next few years. The end result of land based removal would be similar to that of selective dredging. The advantage of land-based removal is that it can be accomplished with conventional equipment such as draglines, bulldozers, or scrapers. The dry sediment can be transported and disposed of immediately by trucks or a series of islands may be built with riprapping surrounding the islands. The riprapping should prevent deposition of sediment from the islands into the lake. In addition to the sediment removal, fish structures such as rock piles, ditches, or walls can be constructed to improve habitat for fish and other aquatic organisms.

Dilution/Flushing

In the event that the Lake Andes-Wagner/Marty II irrigation project is completed within the Lake Andes area a dilution/flushing restoration alternative may be created with off-peak pumping into the south unit. It may be possible to lower the concentration of nutrients within the south unit and flush out algal cells by adding sufficient quantities of nutrient-poor (dilution) water from some additional source providing that the source is nutrient-poor (in this case Lake Francis Case). High amounts of additional water, whether low in nutrients or not, may also be used to flush algae out from the lake faster than they grow. The dilution process depends upon a low concentration of incoming nutrients to effectively dilute the higher concentration in the lake. Concentration of nutrients will also be affected by the degree to which loss of phosphorus to sediments decreases and counters the dilution because of the lack of phosphorus within the dilution water. Lakes with low initial flushing rates are poor candidates because in-lake concentrations could increase unless the dilution water is essentially devoid of phosphorus (EPA, 1990). If the depth of the south unit is maintained at the high water elevation of 1437.25 feet msl it still may be necessary to dredge selectively to increase the depth in certain areas of the lake. These methods of in-lake restoration will not solve all of the problems associated with the lake if watershed restoration does not occur as well. Discharging water within the south unit of Lake Andes is not going to restore the lake to pristine conditions. The productivity of the southern portion of the lake may also be somewhat decreased if there is an excessive amount of nutrient deficient water discharged within the south unit.

RECOMMENDATIONS

Although little information was gained during the course of the study relating to water and nutrient budgets, there was enough information available to reasonably conclude that the problems with Lake Andes stem from inappropriate land use and natural eutrophic conditions. Based upon the information collected and evaluation of the historical data, the Water Resource Management Division of the SD DENR recommends the following activities for the improvement of the Lake Andes and its watershed:

1. Due to the condition of the watershed, the land use recommendations discussed below should be completed regardless of

the outcome of the rest of the restoration plan. These options were selected by the Charles Mix Conservation District, Soil Conservation Service, and SD DENR on the basis of effectiveness and ability to sell these practices to the land owners in the watershed. These recommendations include the following:

A) Conservation District, SCS, Extension Service, and DENR conduct small group meetings with farmers to discuss the effect management of cropland, ag waste, grassland, and riparian areas has on the lake. Agree on needed action.

B) Conservation District and SCS develop, with farmers, Resource Management Plans that address crop residue use, grassed waterways, nutrient application, pesticides, grazing riparian area activities, and ag waste handling. Economic benefits need to be considered. Complete developing these plans (about 100 in number).

C) Conservation District work with Extension Service and County Weed Supervisor to conduct information and education activities on proper pesticide use and safety.

D) Conservation District and SCS establish followup program with landowners and operators to assist in applying conservation practices that not only solve individual farm problems but also have positive impact on the lake.

2. Use of land-based equipment for sediment removal to increase depth, improve fish habitat and reduce the threat of fish kill. Conventional equipment owned by the county or the city can be used to remove as much sediment as desired. Fish structures such as deep pools, rock piles, points, and walls can be constructed to increase recreational fishing. Two or even three years of sediment removal may be necessary. A more accurate time table will be available when the sediment survey is completed.

3. A third option available to the local sponsors is if the Lake Andes-Wagner/Marty II irrigation project is implemented and water is discharged into the south unit during off-peak pumping periods resulting in a dilution/flushing mechanism. Watershed improvement plans that were discussed previously should also be completed during the in-lake restoration. The use of excessive amounts of nutrient deficient water will not solve all of the lakes' water quality problems. If the Lake Andes-Wagner/Marty II irrigation project pumps water into the south unit during favorable off-peak periods, it may necessary to design a monitoring schedule to determine the exact effect this option may have on the Lake Andes ecosystem.

4. Selective dredging may be another option to increase the depth in certain areas and remove some sediment which are rich in

nutrients. It may improve the water quality of the lake and improve the fish habitat.

The local sponsors may select any of the restoration alternatives listed and described in this report or choose to take another plan of action. The recommendations mentioned above are those which the State feels best can solve the problems addressed in this report.

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APPENDIX A. LAKE ANDES LAND USE SURVEY

LAKE ANDES LAND USE SURVEY

The 95,723 acre watershed for the Lake Andes Hydrologic Unit can be broken down into seven separate subwatersheds by treating each main tributary separately (Figure 4). Cropland makes up over 70% of the land use and about 25% is grassland as shown in Table 8. Other land uses are farmsteads and feedlots plus highway/railroad rights of way. The Lake Andes National Wildlife Refuge and other smaller wildlife land acres were included in the grassland acres. It is estimated that about 15% of the farmstead/feedlot acres are in farmstead windbreaks.

Dominate soils in the 7 watersheds are Highmore, Eakin, and Ethan silt loams. Highmore silt loam is a deep, well drained, nearly level soil on uplands. It is well suited for cropland acres in the Lake Andes HU. Measures that conserve moisture are the main conservation need. Leaving crop residue on the soil surface is a good example.

Eakin silt loam is a deep, well drained soil on the higher convex slopes. Steepness of these slopes are from 2% to 6%. Most slopes are long and smooth, but some are short and complex. These soils are well suited to cultivated crops. Conservation measures that control erosion and conserve moisture are needed.. Examples are minimizing tillage and leaving crop residue on the surface. Contour farming, grassed waterways, and terraces can help. Slopes in some areas, however, are too short or too irregular for contouring and terracing.

Ethan loam is a deep, well drained, undulating soil on knolls and ridges. It is easy to recognize by the much lighter tan color on the surface than found in the Eakin soil. Ethan soil is not as well suited for crop production as the Eakin soil or the Highmore soil. Because it is so intermixed with the Eakin soils it , generally, is difficult to manage separately. Organic matter content and fertility are low in the Ethan soil. The high content of lime in the surface layer adversely affects the availability of plant nutrients. Main concerns in managing this soil are controlling erosion and conserving moisture. Increasing the organic matter content and improving fertility also need to be addressed. Minimizing tillage, leaving crop residues on the soil surface, and including grasses and legumes in the cropping system help to control erosion, conserve moisture, increase the content of organic matter, and improve fertility. Contour farming, grassed waterways, and terraces also can help to control erosion, but in some areas, slopes are too short or too irregular for contouring and terracing.

Other soils in the cropland acres that need to be addressed are Onita silt loam and Tetonka silt loam.

Onita silt loams are deep, moderately well drained soils on uplands. They are occasionally flooded. There soils are well suited to cultivated crops. Conserving moisture is the main management concern and leaving crop residue on the soil surface is a good practice. In some years field work is delayed due to wetness but in most years the additional moisture is beneficial.

Tetonka silt loams are deep poorly drained soils in depressions in the uplands. They are ponded during periods of snowmelt and heavy rainfall. These soils are poorly suited to cultivated crops. Most areas of Tetonka soil located in cropland fields had some surface drainage installed where drainage could feasible be done. This was done to bring these wetlands areas into crop production and to eliminate having to farm around them. Tetonka soils are important for floodwater retention groundwater recharge, catch basins for cropland nutrients, pesticide and silt runoff, as well as habitat for many kinds of wildlife.

Some landowners are very aware of these values and practice wetlands conservation. Other landowners need to be educated on these values and still others will need financial incentives to restore and conserve this valuable resource. Grassland soils vary greatly. Most grassland acres are on soils that are too steep, too shallow or too wet to be used for cultivate crops. About 60% of the grassland is in rangeland (native grasses and forbs), about 35% is introduced grasses and/or legumes as permanent cover, and the remainder is wildlife land that normally is not hayed or grazed.

Ethan and Clarno loams on 9-15% slopes plus Betts and Ethan loams on 9-25% slopes are common soils on the steeper rangeland. Eakin and Ethan loams on 6-9% slopes common where introduced grasses and legumes for permanent cover has been established. Pothole wetland soils are Tetonka and Worthing. A few potholes may be Hoven soils. Along the larger creeks the floodplains are usually Bon soils. Andes Creek has some areas next to it that are Delmont and Enet soils. These areas are where small gravel pits have been or are now active.

More complete information about the soils in the Lake Andes Hydrologic Unit is available in the Charles Mix County and Douglas County Soil Surveys. See the Land Use Table (Table 8) and map of the subwatersheds (Figure 4) for more information on problem areas.

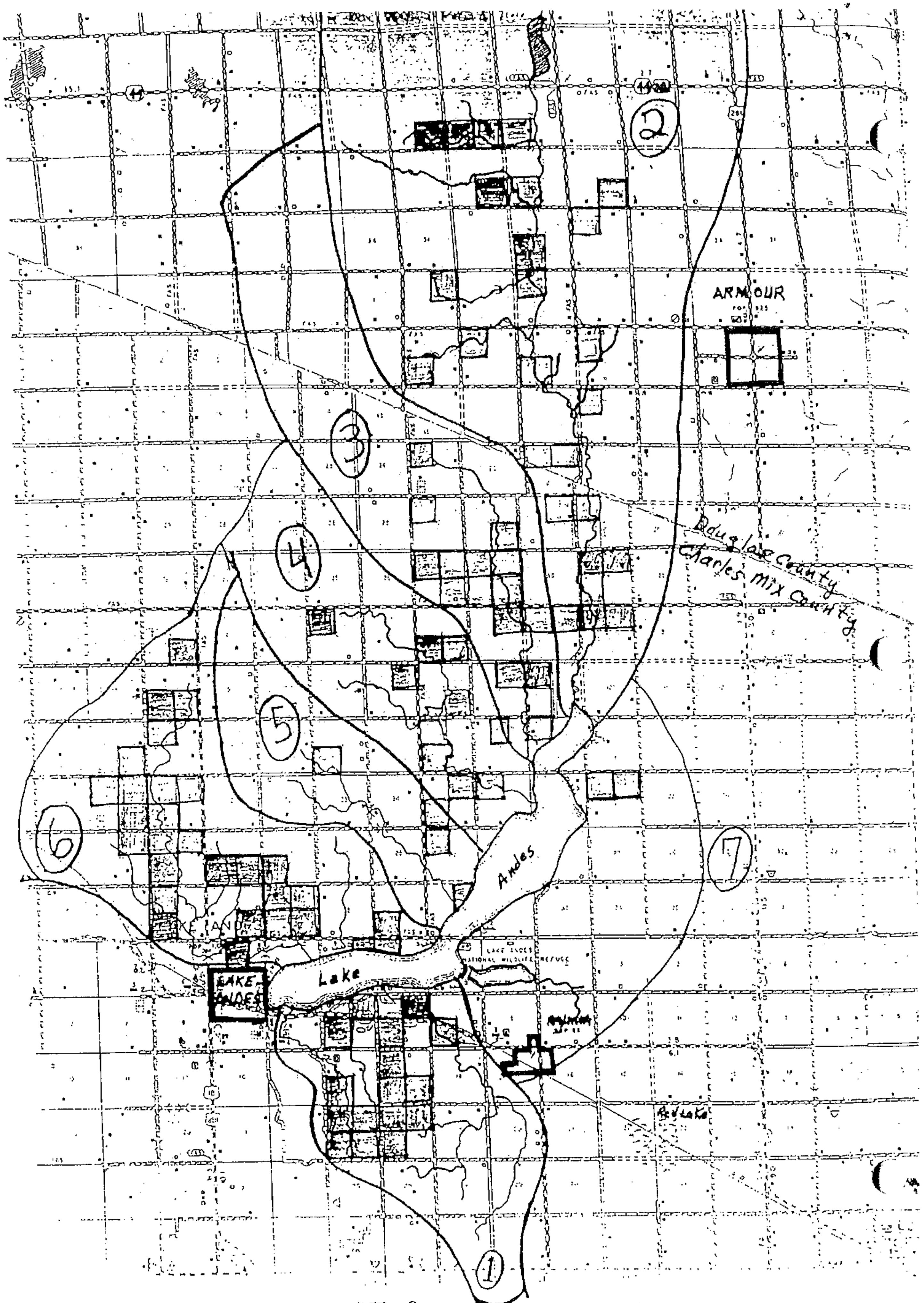
Almost all of the grassland acres need improved grazing management. Many acres are overused so that desirable species are set back allowing weeds to become a problem. Soil erosion occurs in some creek channels. Managing for improving vegetative cover along the creek channels and riparian areas would significantly reduce erosion occurring in these channels and greatly reduce sediment being delivered to Lake Andes. This would reduce the potential for delivery of fertilizers and pesticides coming from cropland. Improving riparian areas can significantly reduce the potential for nutrients in runoff from livestock feeding areas being delivered to the lake.

LAKE ANDES FEEDLOT SURVEY

Charles Mix Conservation District staff visited several farms located adjacent to the lake and along major streams in each of the seven subwatersheds. Farmers were very cooperative in answering questions about their operation and how ag waste was being handled. A good example of how ag waste can be handled is found in Watershed No. 4 which has the Lakeview Colony with a large turkey operation and new hog confinement operation. The Colony is installing ag waste handling facilities in cooperation with the Department of Environment and Natural Resources.

Almost all farmers apply manure from their feedyards to cropland. This is usually done in the spring or after small grain harvest in the summer. Problems for the lake come from winter feeding areas on the creeks and from storm runoff through the feed yards. In a few cases fixing this problem can be done simply by moving to a less hazardous feeding area or diverting storm runoff away from feedyards and increasing the size of buffer areas between feedyards and the lake or streams involved in the Lake Andes Watershed. In many cases, however, the solution will be more difficult and expensive.

The recommendations that were selected to alleviate these problems were previously discussed on page 23 and 24.



ARMOUR
Douglas County
Charles Mix County
Andes
Lake
LAKE ANDES
LAKE ANDES NATIONAL WILDLIFE REFUGE
Red Lake
1
2
3
4
5
6
7

Potential

Table 8. LAKE ANDES LAND USE SURVEY

	Subwatershed Number							
	1	2	3	4	5	6	7	Total
Watershed Acres	12,063	36,824	8,449	7,955	7,770	15,225	7,437	95,723
Cropland Acres	7,104	26,050	5,700	5,442	6,230	11,376	5,895	67,797
Cropland % Watershed	59	71	68	68	80	75	79	71
HEL Cropland Acres	1,439	755	16	98	0	1,171	0	3,479
HEL % Cropland	20	3	0.3	2	0	10	0	5
Cropland Eroding >1.5 T	1,230	3,831	1,474	661	497	2,085	76	9,854
Highly Eroding % Cropland	17	15	26	12	8	18	1	15
CRP Acres	146	51	117	236	0	326	167	1,043
CRP % Cropland	2	0.2	2	4	0	3	3	2
Grassland Acres	4,297	9,811	2,457	2,089	1,265	3,119	1,249	24,279
Grassland % Watershed	36	26.5	29	26	16	20	17	25
Farmstead Feedlot Acres	233	570	113	93	136	319	128	1,592
Fstd/Fdlt % Watershed	2	1.5	1	1	2	2	2	2
Highway Railroad Right of Way	429	393	179	331	139	411	173	2,055
Hwy/RR % Watershed	3	1	2	4	2	3	2	2

APPENDIX B. DESCRIPTION OF WATER QUALITY PARAMETERS

WATER QUALITY PARAMETERS

1. **Laboratory Analysis**

   a. Fecal Coliform (organisms/100ml) indicates fecal contamination and thus potential human health hazards. Fecal coliform bacteria are bacteria which live only in the digestive tract of warm-blooded animals. These bacteria are considered to be an indicator of sewage pollution or livestock manure.

   b. Laboratory pH is a measure of the hydrogen ion activity which directly affects the toxicity (solubility) of heavy metals in water, among other items. The pH scale is a number range between 1 and 14, with 7 being neutral. Any value less than 7 is considered acidic and any value greater than 7 is considered basic. The pH range for most natural lakes is between the 6 and 9. Deviation, from the neutral pH 7, is a result of the decomposition of salts as they reacted with water. Gases such as carbon dioxide, hydrogen sulfide, and ammonia have a significant effect on pH. The pH of a lake is directly related to the geography of the surrounding area.

   c. Total Alkalinity (mg/L) refer to the quantity of different compounds that shift the pH to the alkaline side of neutrality. Alkalinity generally the result of bicarbonates but is expressed as a sum of hydroxide, carbonate, and bicarbonate. Carbonate and bicarbonate are common in water because carbonate minerals are common in nature. The contribution to alkalinity by hydroxides is rare in nature. Thus alkalinity is directly related to geography. Expected total alkalinities in nature range from 20 to 200 mg/L.

   d. Total Solids (mg/L) are all the suspended and dissolved materials present in water. These are the materials left after the raw water has evaporated off.

   e. Total Dissolved Solids (mg/L) include salts and organic residue which pass through a filtered water sample. Total dissolved solids can also be determined by subtracting the total solids by the suspended solids.

   f. Total Suspended Solids (mg/L) include organic and inorganic materials that are not dissolved. This parameter can indicate the sediment load into a body of water and possible problems to the biological community.

Suspended solids does not include a measure of larger particles that are moved along the stream bed during high flows.

g. Ammonia-Nitrogen (mg/L) is generated by bacteria as a primary end product of decomposition of organic matter. Ammonia is the form of nitrogen directly available to plants as a nutrient for growth. High ammonia concentrations can be used to demonstrate organic pollution.

h. Unionized Ammonia (mg/L) is often the most abundant inorganic form of nitrogen. Nitrate constitutes the inorganic form of nitrogen assimilated by algae and large aquatic plants. In natural waters the concentrations are usually low, around 0.1 mg/L. Some sources for inorganic nitrogen are agricultural activities, sewage, and atmospheric pollution.

i. Nitrate-Nitrogen (mg/L) is often the most abundant inorganic form of nitrogen. Nitrate constitutes the inorganic form of nitrogen assimilated by algae and larger hydrophytes. In natural waters the concentrations are usually low, around 0.1 mg/L. Some sources for inorganic nitrogen are agricultural activities, sewage, and atmospheric pollution.

j. Total Kjeldahl Nitrogen (mg/L) is used to measure both total nitrogen and organic nitrogen. Ammonia is subtracted from total kjeldahl nitrogen to acquire the amount of organic nitrogen present. Organic forms of nitrogen can be broken down into different compounds which are then used by phytoplankton. Organic nitrogen can be released from living macrophytes and large quantities can also be released from decaying macrophytes.

k. Total Nitrogen (mg/L) is the sum of nitrate-nitrite nitrogen plus total kjeldahl nitrogen. Total nitrogen to total phosphorus rations are used to identify which nutrient is limiting to algae growth in lake waters. a lake is usually defined as phosphorus limited if the total nitrogen/total phosphorus ratio is greater than 10:1.

l. Total Phosphorus (mg/L) represents all of the phosphorus found in the water sample. Phosphorus is an element which is essential to all life. Not all of the phosphorus is immediately available to aquatic plants and algae. Soil can sorb to phosphorus which is released when dissolved oxygen levels are depleted. W n concentrations are high, nuisance growth of aquatic plants or algae may result. Sources of phosphorus are from agriculture, sewage, and from the decomposition of organic matter.

m. Ortho-Phosphorus (mg/L) is a form of phosphorus which is readily available for uptake by plants.

2. **FIELD ANALYSIS**

a. Water Temperature (^{0}c) is taken since it has a considerable effect on the chemical process in a lake. Also, temperature is important to fish life and other aquatic species.

b. Field pH is a measure of the hydrogen ion activity which directly effects the toxicity (solubility) of heavy metals in water, among other items. The pH scale is a number range between 1 and 14, with 7 being neutral. Any value less than 7 is considered acidic and any value greater than 7 is considered basic.

c. Dissolved Oxygen (mg/L) the dissolved oxygen content of water results from (1) the activities of growth and decomposition in the lake system; and (2) the air-water interface and the distribution by wind driven mixing. Oxygen levels less than 3.0 mg/L are stressful to aquatic vertebrates and most other aquatic life.

d. Climate Conditions - wind, precipitation, air, and temperature (^{0}c).

e. Visual Observations - septic conditions, odor, water color, turbidity, or anything unusual worth noting.

f. Water Depth in tributaries it is taken to assist in calculating flow measurements. Water depth in lakes is used as reference points and to notice changes in lake elevation.

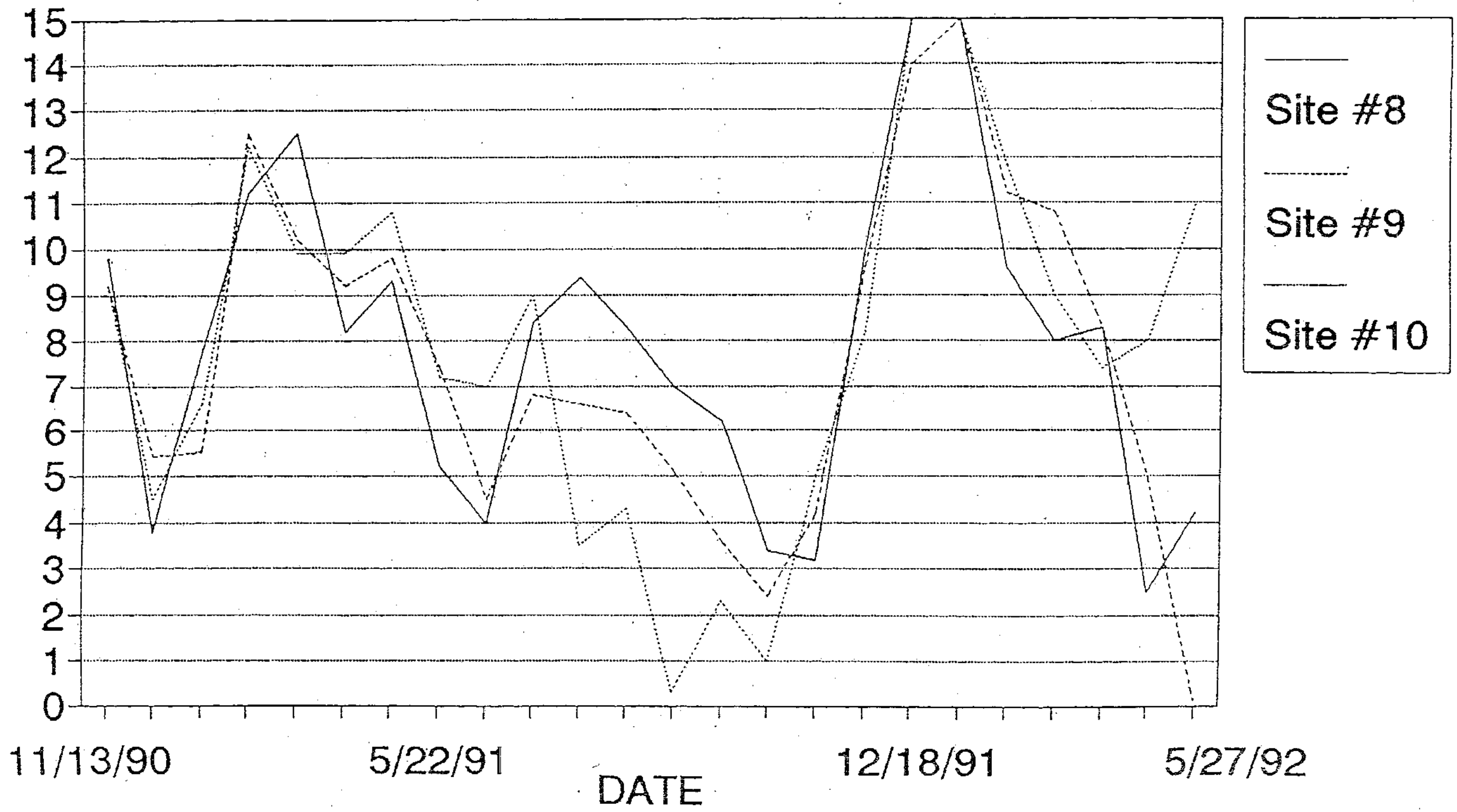
g. Secchi Disk is taken for a comparison of water clarity.

3. **In-Lake Sediment Sampling**

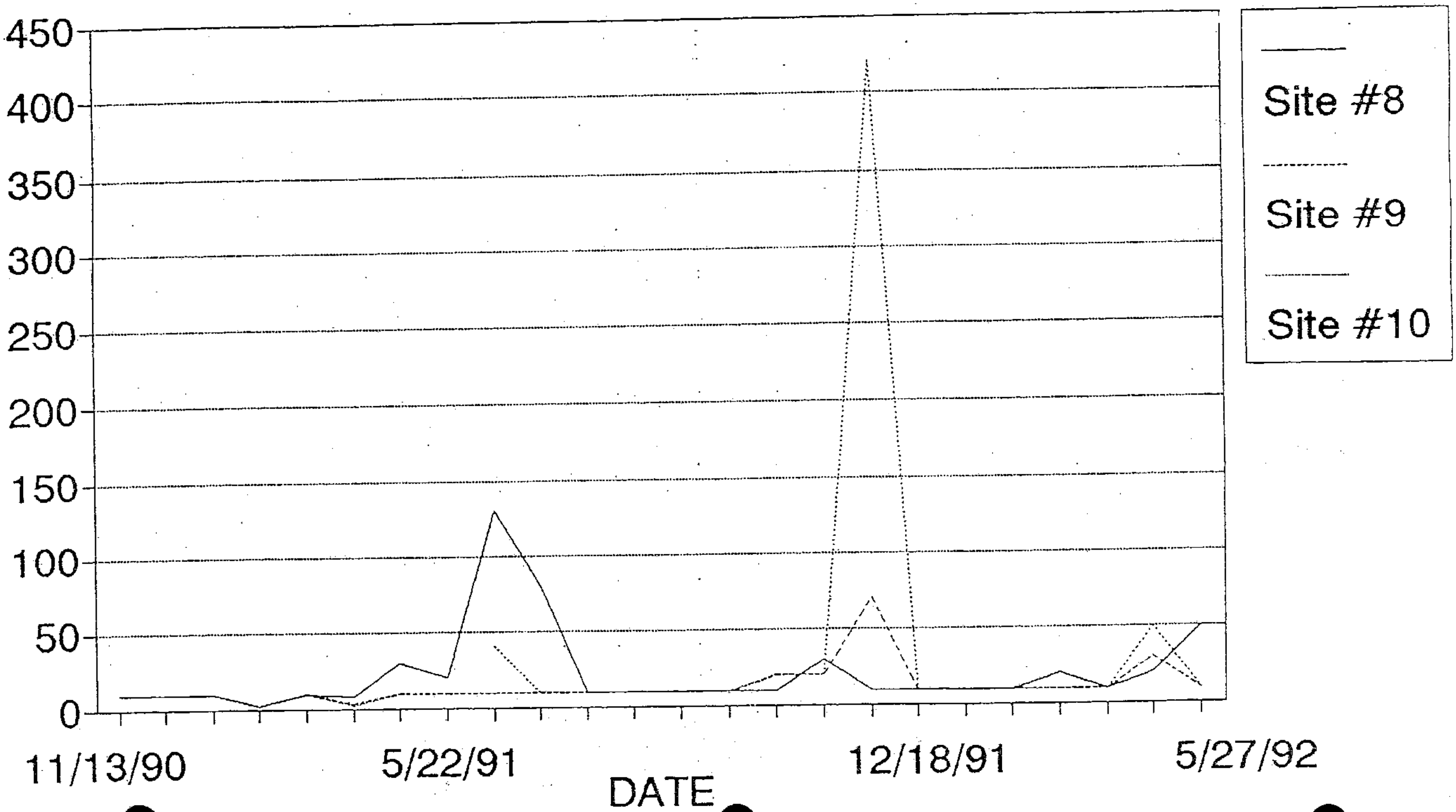
a. Sediment Surveys are conducted and topographic maps are made to determine sediment volumes and concentrations in the lake.

APPENDIX C. GRAPHS COMPARING PARAMETERS OF THE IN-LAKE SAMPLING SITES

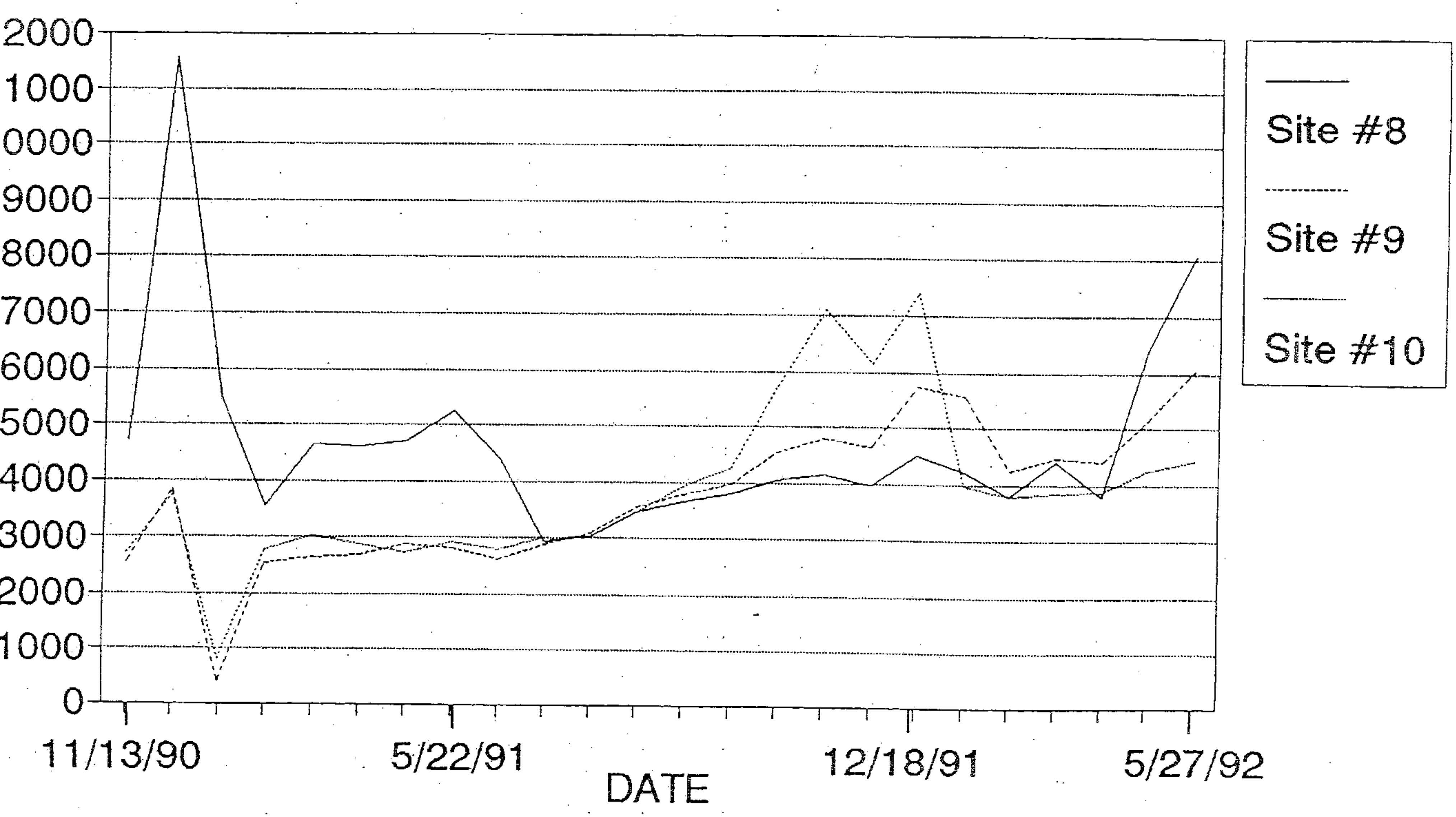
DISSOLVED OXYGEN FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10

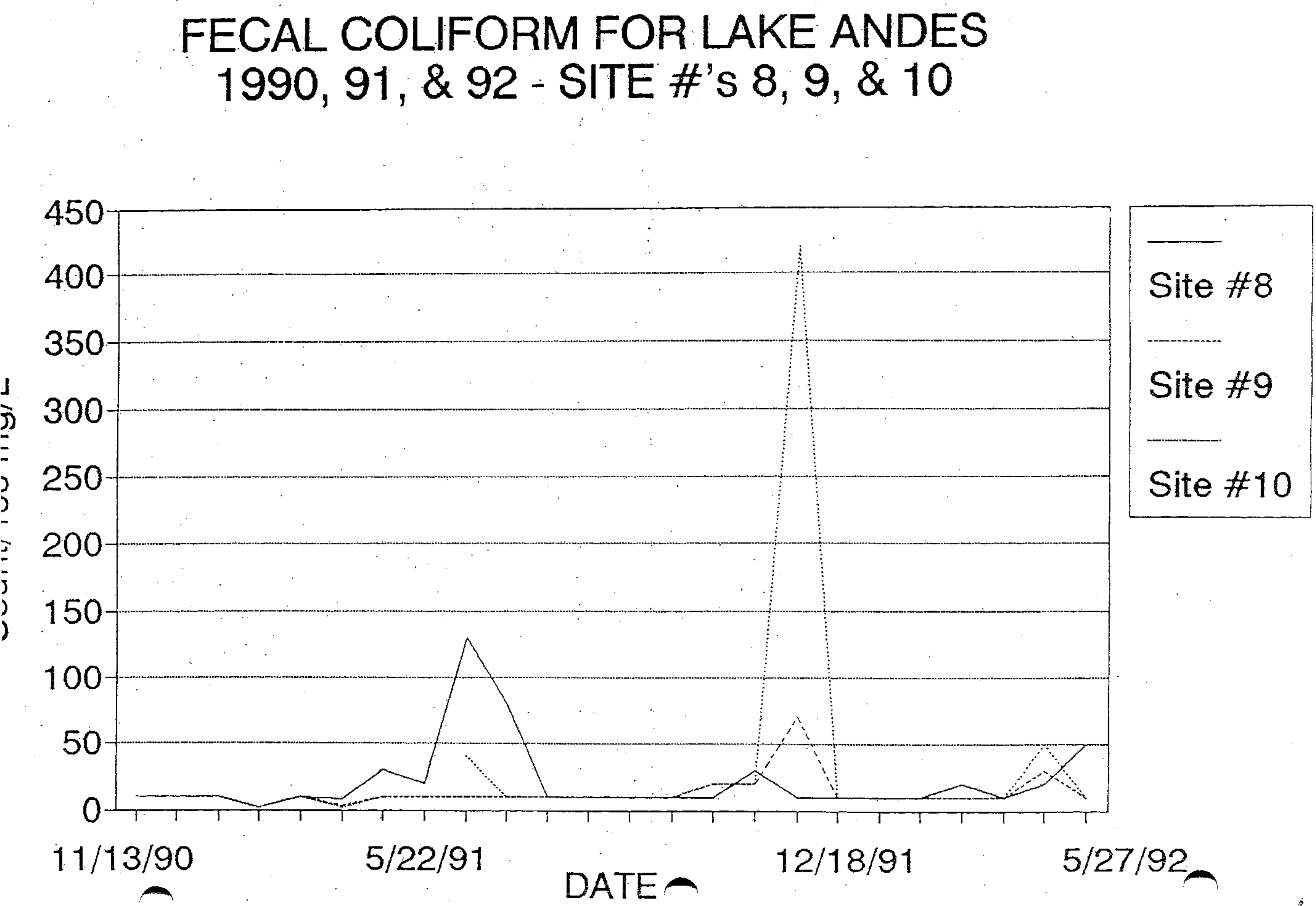


FECAL COLIFORM FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10

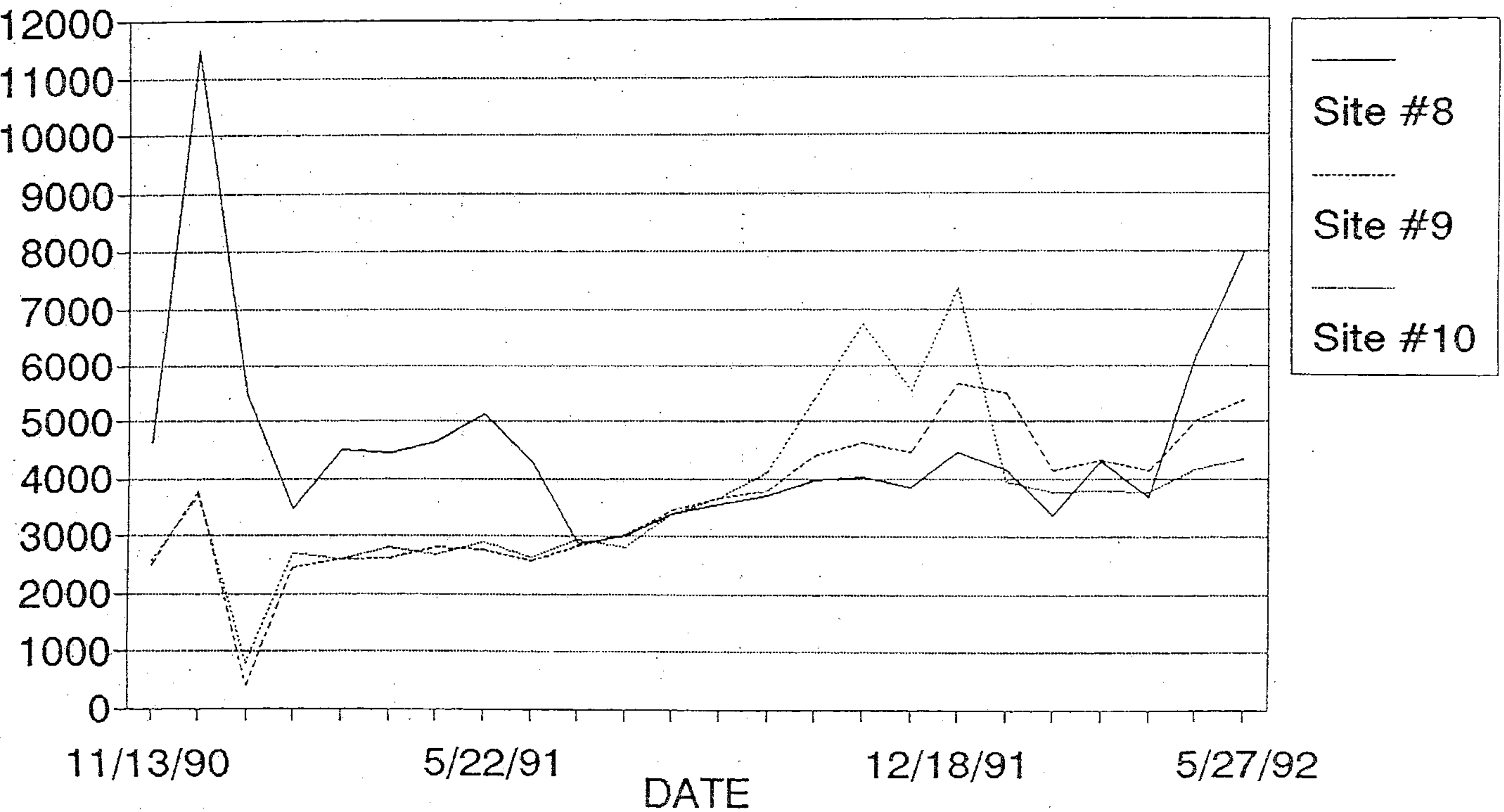


TOTAL SOLIDS FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10

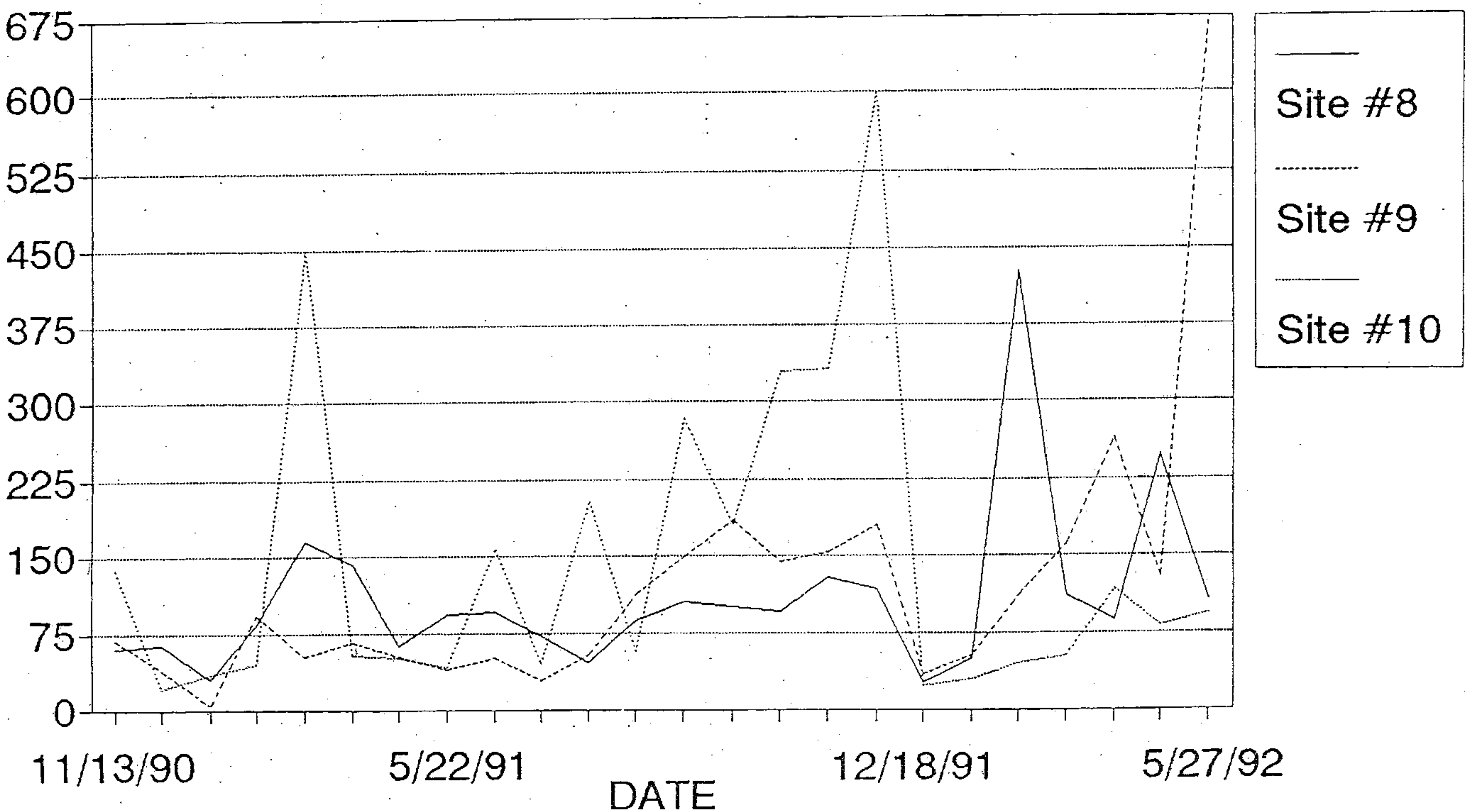



FECAL COLIFORM FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10
450
400
350
300
250
200
150
100
50
0
11/13/90
5/22/91
12/18/91
5/27/92
DATE
Site #8
Site #9
Site #10

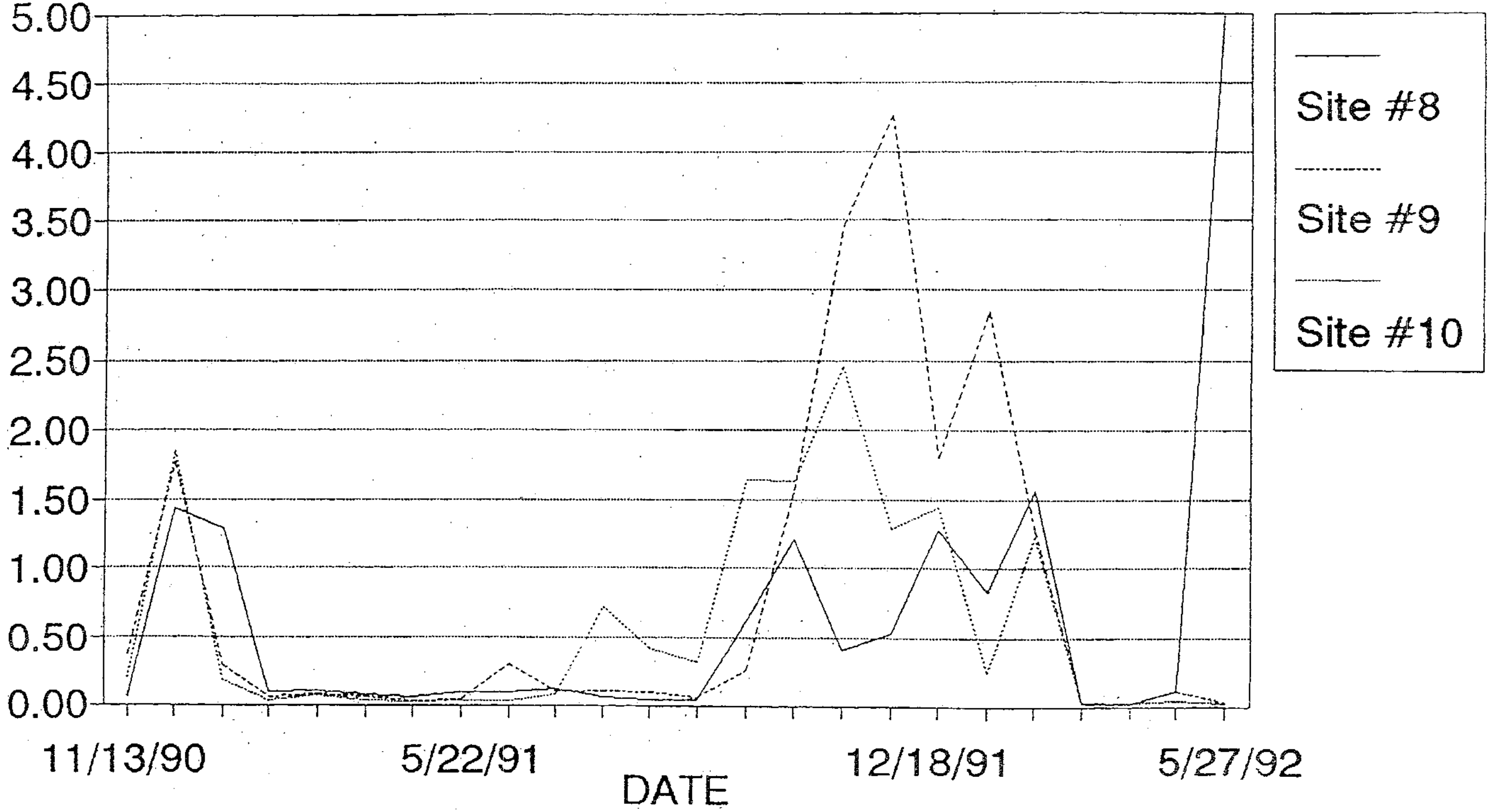
TOTAL DISSOLVED SOLIDS FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10



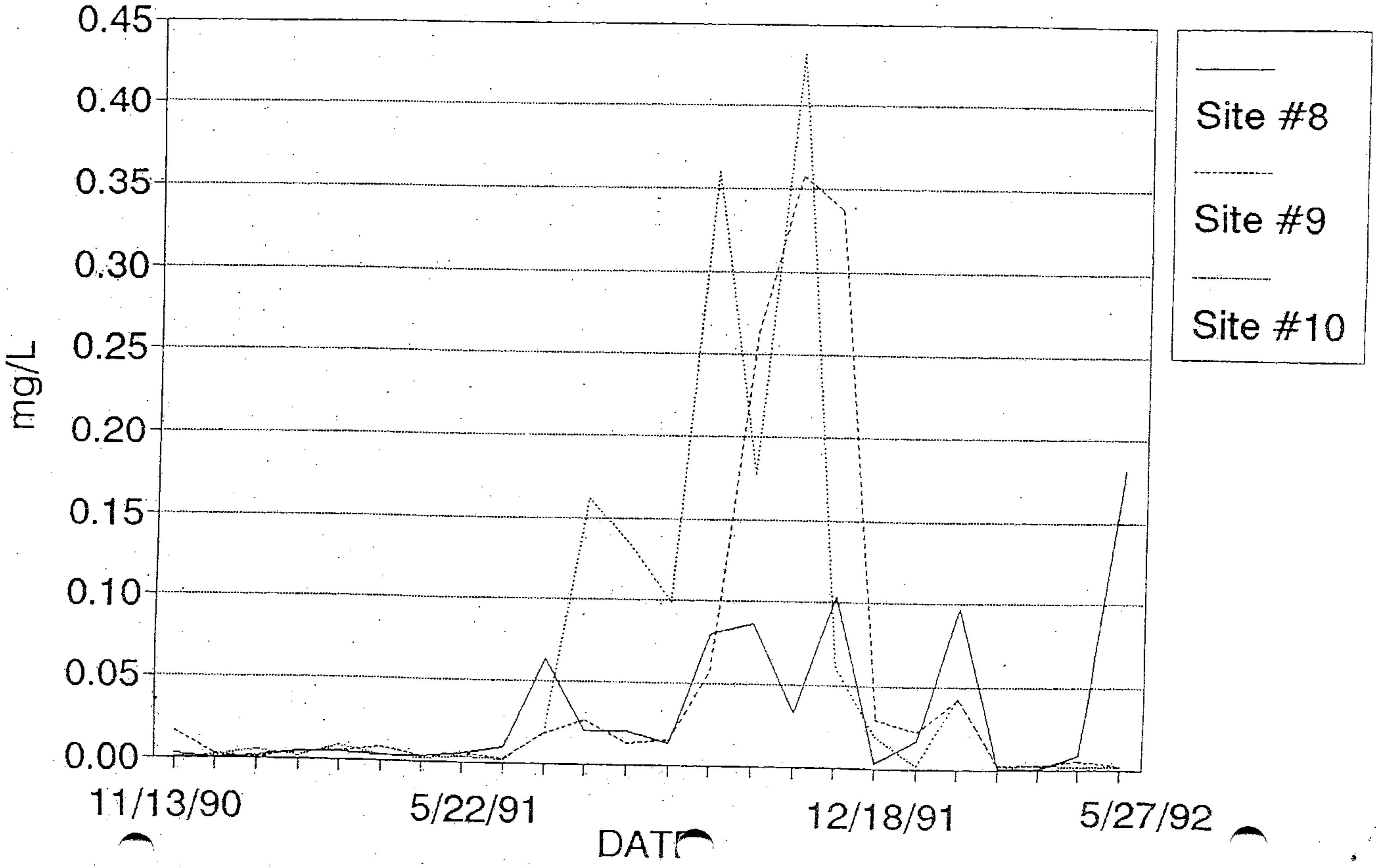
TOTAL SUSPENDED SOLIDS FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10



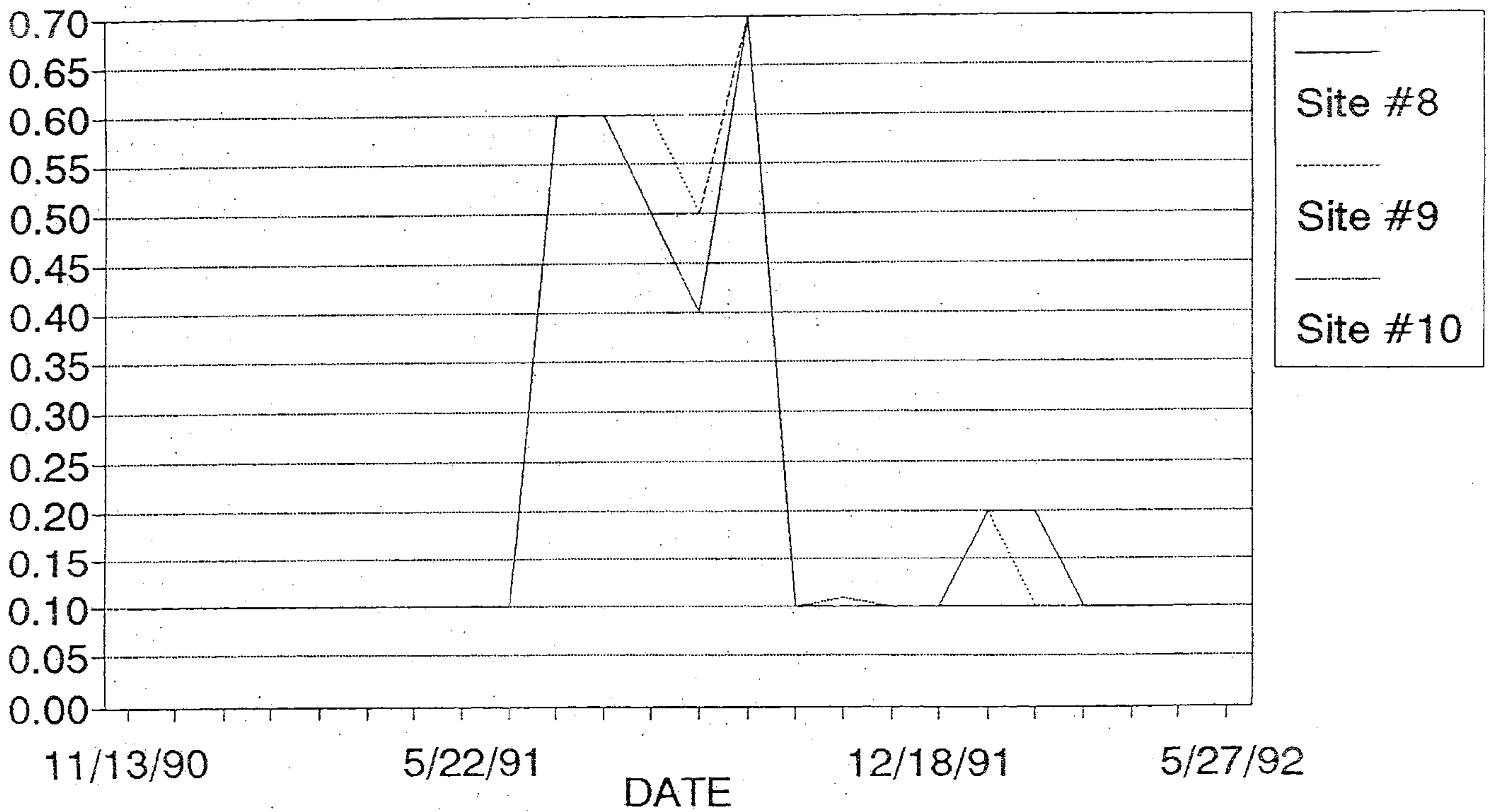
AMMONIA CONCENTRATION FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10



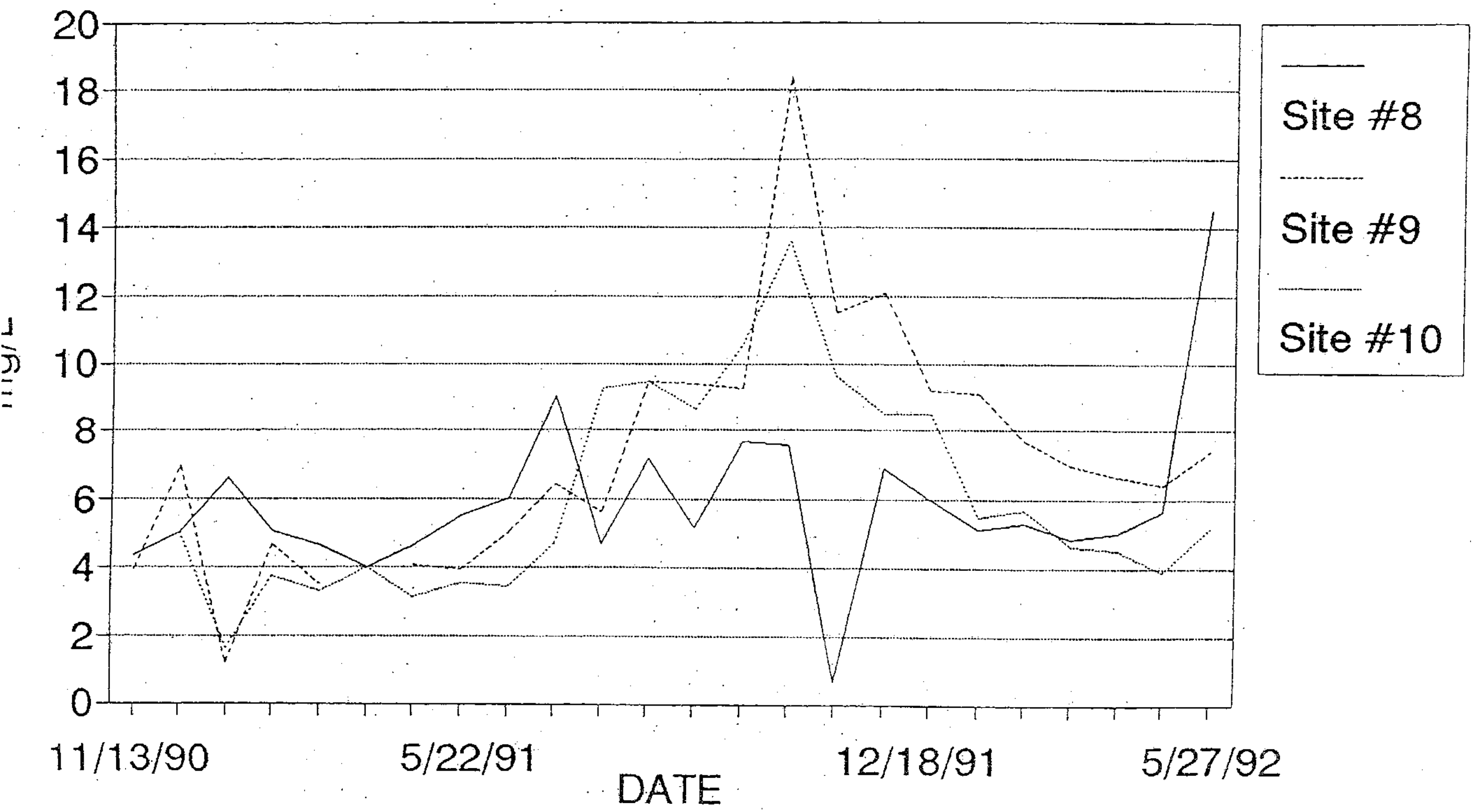
UNIONIZED AMMONIA FOR LAKE ANDES
1990, 91, & 92 - SITE #'S 8, 9, & 10



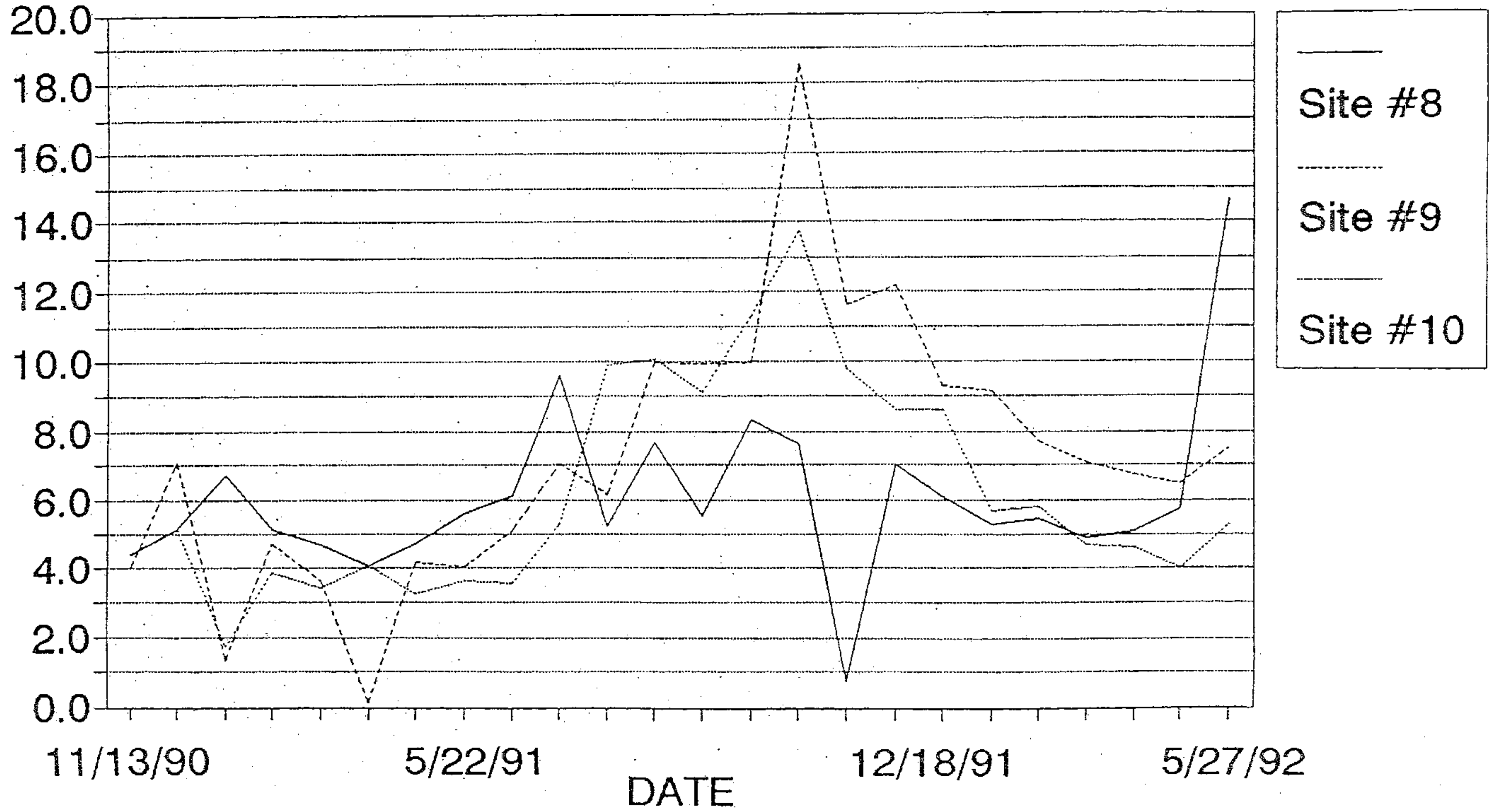
NO3 - NO2 FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10



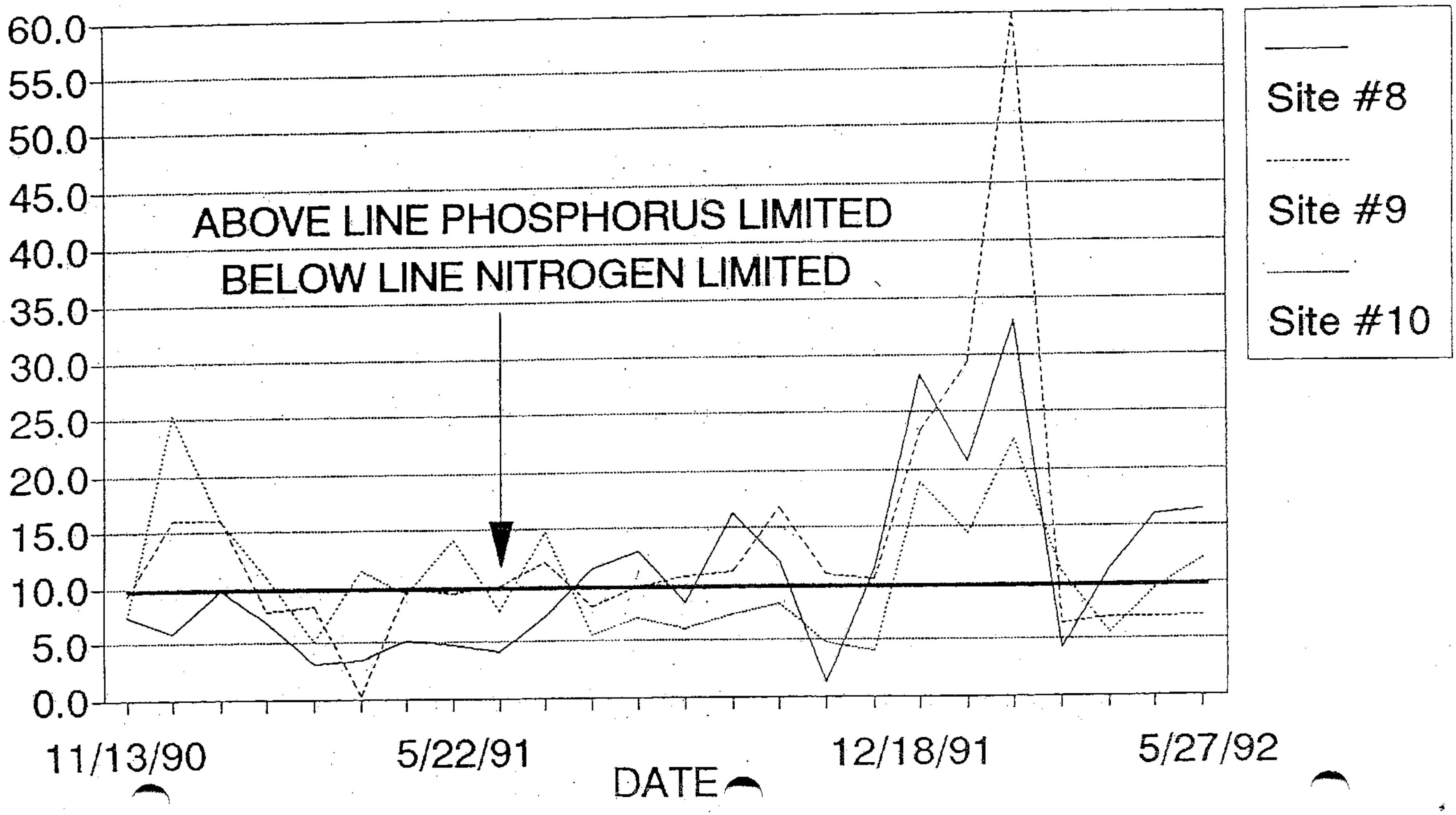
TOTAL KJELDAHL NITROGEN FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10



TOTAL NITROGEN FOR LAKE ANDES
1990, 91, & 92 - SITE #'s 8, 9, & 10



NITROGEN TO PHOSPHORUS RATIO
1990, 91, & 92 - SITE #'s 8, 9, & 10



APPENDIX D. UNITED STATES GEOLOGICAL SURVEY WATER QUALITY DATA

06452380 ANDES CREEK NEAR ARMOUR, SD

LOCATION.--Lat 43°15'23", long 98°24'08", in SW¼NW¼ sec.3, T.98 N., R.64 W., Charles Mix County, Hydrologic Unit 10140101, at bridge 2.8 mi east of U.S. Highway 281 and 2 mi north of Lake Andes.

PERIOD OF RECORD.--April 1983 to current year.

REMARKS.--The stream flows only during the wet season. Samples are collected only when flow is greater than 2 ft^3/s.

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	TUR-BID-ITY (NTU)	BARO-METRIC PRES-SURE (MM OF HG)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCAR WH WAT TOT FL MG/L A CACO3
MAR 20...	0840	37	900	7.70	-5.0	0.0	12	734	12.4	88	350	23
APR 18...	1330	--	670	7.90	11.5	7.0	42	710	9.3	82	260	17
MAY 07...	0845	14	1400	7.83	8.5	11.5	1.5	721	6.5	63	610	39
JUN 25...	0955	33	670	7.65	28.0	22.5	7.0	718	3.8	47	270	9
JUL 10...	0845	11	970	7.81	24.0	24.5	6.2	717	2.2	28	390	13

DATE	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	PERCENT SODIUM	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY LAB (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS RESIDU AT 105 DEG. C SUS-PENDED (MG/L
MAR 20...	81	35	38	18	0.9	20	118	300	23	18	600	7
APR 18...	60	26	27	18	0.8	15	91	230	9.9	13	460	--
MAY 07...	140	63	76	21	1	20	217	530	32	2.5	1060	5
JUN 25...	62	28	28	17	0.8	19	177	150	10	16	454	14
JUL 10...	90	40	48	20	1	20	255	230	21	18	670	24

DATE	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	SOLIDS, DIS-SOLVED (TONS PER DAY)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	BORON, DIS-SOLVED (UG/L AS B)	PHOS-PHORUS ORTHO DIS-SOLVED (MG/L AS P)
MAR 20...	590	0.82	60	0.05	0.06	2.70	2.65	2.70	0.63	0.59	70	0.51
APR 18...	440	0.63	--	0.02	--	1.00	0.98	--	--	0.37	60	0.31
MAY 07...	1000	1.4	40	<0.01	<0.01	<0.10	--	<0.10	0.49	0.44	180	0.40
JUN 25...	420	0.62	40	0.04	--	0.14	0.10	--	--	0.93	100	0.87
JUL 10...	620	0.91	20	0.11	--	0.64	0.53	--	--	0.88	160	0.84

DATE	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	CYANIDE DIS-SOLVED (MG/L AS CN)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)
MAR 20...	0.53	4	80	<0.5	<1	<1	<3	2	<0.01	170	<1
APR 18...	--	3	54	<0.5	<1	2	<3	4	<0.01	63	[illegible]
MAY 07...	0.41	4	65	<0.5	<1	<1	<3	2	<0.01	18	[illegible]
JUN 25...	--	10	60	<0.5	<1	<1	<3	1	<0.01	27	<5
JUL 10...	--	12	54	<0.5	<1	<1	<3	1	<0.01	10	<5

06452380 ANDES CREEK NEAR ARMOUR, SD--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	ANTI-MONY, DIS-SOLVED (UG/L AS SB)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	THAL-LIUM, DIS-SOLVED (UG/L AS TL)	ZINC, DIS-SOLVED (UG/L AS ZN)	ARSENIC TOTAL (UG/L AS AS)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA)	BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE)
MAR 20...	60	<0.1	3	<1	13	1	<1	11	3	100	<10
APR 18...	170	<0.1	12	<1	9	<1	<1	11	--	--	--
MAY 07...	320	<0.1	4	<1	3	<1	<1	8	5	100	<10
JUN 25...	450	<0.1	5	1	1	<1	<1	12	--	--	--
JUL 10...	890	<0.1	5	<1	1	<1	<1	8	--	--	--

DATE	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	BORON, TOTAL RECOV-ERABLE (UG/L AS B)	CYANIDE TOTAL (MG/L AS CN)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI)	ANTI-MONY, TOTAL (UG/L AS SB)	SELE-NIUM, TOTAL (UG/L AS SE)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG)	THAL-LIUM, TOTAL (UG/L AS TL)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
MAR 20...	<1	120	<0.01	4	<1	13	1	<1	19	1.9	98
APR 18...	--	--	--	--	--	--	--	--	98	--	89
MAY 07...	<1	200	<0.01	<1	<1	3	<1	<1	6	0.23	89
JUN 25...	--	--	--	--	--	--	--	--	15	1.3	96
JUL 10...	--	--	--	--	--	--	--	--	22	0.65	88

06452383 LAKE ANDES TRIBUTARY NO. 3 NEAR ARMOUR, SD

LOCATION.--Lat 43°15'23", long 98°25'58", in SW¼NE¼ sec.5, T.98 N., R.64 W., Charles Mix County, Hydrologic Unit 10140101, at bridge 4.3 mi east of U.S. Highway 281.

PERIOD OF RECORD.--February to September 1986.

REMARKS.--Streamflow occurs only during the wet season. Samples are taken when flow exceeds 2 ft^3/s.

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	TUR-BID-ITY (NTU)	BARO-METRIC PRES-SURE (MM OF HG)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3
MAR 20...	1105	3.6	1240	7.90	2.0	3.0	13	730	11.6	90	570	430
APR 18...	1110	31	1010	8.00	12.5	11.5	28	708	9.6	95	420	300

DATE	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	PERCENT SODIUM	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY LAB (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)
MAR 20...	120	66	54	16	1	20	140	540	27	19	968	10
APR 18...	89	47	42	17	0.9	17	114	390	15	14	744	--

DATE	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	SOLIDS, DIS-SOLVED (TONS PER DAY)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	BORON, DIS-SOLVED (UG/L AS B)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)
MAR 20...	930	1.3	9.4	0.06	0.06	3.80	3.74	3.80	0.76	0.71	80	0.65
APR 18...	680	1.0	62	0.02	--	1.20	1.18	--	--	0.51	70	0.42

DATE	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	CYANIDE DIS-SOLVED (MG/L AS CN)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)
MAR 20...	0.65	3	88	<0.5	1	<1	<3	1	<0.01	55	1
APR 18...	--	3	74	<0.5	<1	2	<3	3	<0.01	48	<1

DATE	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	ANTI-MONY, DIS-SOLVED (UG/L AS SB)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	THAL-LIUM, DIS-SOLVED (UG/L AS TL)	ZINC, DIS-SOLVED (UG/L AS ZN)	ARSENIC TOTAL (UG/L AS AS)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA)	BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE)
MAR 20...	160	<0.1	3	<1	21	1	<1	67	3	200	<10
APR 18...	78	<0.1	9	<1	17	<1	<1	9	--	--	--

DATE	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	BORON, TOTAL RECOV-ERABLE (UG/L AS B)	CYANIDE TOTAL (MG/L AS CN)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI)	ANTI-MONY, TOTAL (UG/L AS SB)	SELE-NIUM, TOTAL (UG/L AS SE)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG)	THAL-LIUM, TOTAL (UG/L AS TL)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
MAR 20...	<1	80	<0.01	20	<1	22	<1	<1	20	0.19	99
APR 18...	--	--	--	--	--	--	--	--	63	5.3	99

06452386 LAKE ANDES TRIBUTARY NO. 2 NEAR LAKE ANDES, SD

LOCATION.--Lat 43°12'43", long 98°26'45", in SE¼SE¼SE¼ sec.18, T.97 N., R.64 W., Charles Mix County, Hydrologic Unit 10140101, at culvert 3 mi north and 4.6 mi east of town of Lake Andes.

PERIOD OF RECORD.--October 1984 to September 1986.

REMARKS.--Streamflow occurs only during wet season. Water-quality samples are taken only when streamflow exceeds 2.0 ft³/s.

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	TUR-BID-ITY (NTU)	BARO-METRIC PRES-SURE (MM OF HG)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3
MAR 20...	1355	6.8	860	7.80	3.0	5.0	34	730	11.8	97	360	270
APR 17...	1425	74	940	7.90	5.0	2.0	66	715	13.3	103	360	270

DATE	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	PERCENT SODIUM	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY LAB (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)
MAR 20...	88	34	32	15	0.8	20	89	310	22	22	621	50
APR 17...	85	37	38	18	0.9	16	96	350	13	13	726	--

DATE	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	SOLIDS, DIS-SOLVED (TONS PER DAY)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	BORON, DIS-SOLVED (UG/L AS B)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)
MAR 20...	580	0.84	11	0.07	0.08	5.80	5.73	6.00	0.70	0.54	40	0.51
APR 17...	610	0.99	145	0.02	--	1.10	1.33	--	--	0.25	50	0.192

DATE	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	CYANIDE DIS-SOLVED (MG/L AS CN)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)
MAR 20...	0.54	3	86	<0.5	<1	<1	<3	4	<0.01	870	<1
APR 17...	--	3	67	<0.5	<1	<1	<3	2	<0.01	41	1

DATE	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	ANTI-MONY, DIS-SOLVED (UG/L AS SB)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	THAL-LIUM, DIS-SOLVED (UG/L AS TL)	ZINC, DIS-SOLVED (UG/L AS ZN)	ARSENIC TOTAL (UG/L AS AS)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA)	BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE)
MAR 20...	140	<0.1	6	<1	13	<1	<1	34	3	200	<10
APR 17...	170	<0.1	3	<1	7	<1	<1	11	--	--	--

06452386 LAKE ANDES TRIBUTARY NO. 2 NEAR LAKE ANDES, SD--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	BORON, TOTAL RECOV-ERABLE (UG/L AS B)	CYANIDE TOTAL (MG/L AS CN)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI)	ANTI-MONY, TOTAL (UG/L AS SB)	SELE-NIUM, TOTAL (UG/L AS SE)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG)	THAL-LIUM, TOTAL (UG/L AS TL)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
MAR											
20...	1	40	<0.01	23	<1	12	1	<1	66	1.2	99
APR											
17...	--	--	--	--	--	--	--	--	178	36	92

06452389 LAKE ANDES TRIBUTARY NO. 1 NEAR LAKE ANDES, SD

LOCATION.--Lat 43°11'25", long 98°27'57", in NE¼NE¼SE¼ sec.25, T.97 N., R.65 W., Charles Mix County, Hydrologic Unit 10140101, at culvert 1 mi north and 3 mi east of town of Lake Andes.

PERIOD OF RECORD.--October 1984 to September 1986.

REMARKS.--Streamflow occurs only during the wet season. Samples are taken when flow exceeds 2 ft³/s.

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	TUR-BID-ITY (NTU)	BARO-METRIC PRES-SURE (MM OF HG)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3
MAR 21...	1500	2.4	510	7.80	14.0	7.0	36	723	10.4	90	200	[illegible]
APR 18...	0845	19	490	7.90	14.0	7.5	41	708	10.6	95	190	[illegible]

DATE	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	PERCENT SODIUM	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY LAB (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)
MAR 21...	48	20	12	10	0.4	25	95	130	12	19	370	52
APR 18...	45	20	14	12	0.4	17	78	150	7.1	13	352	--

DATE	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	SOLIDS, DIS-SOLVED (TONS PER DAY)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)	BORON, DIS-SOLVED (UG/L AS B)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)
MAR 21...	320	0.5	2.4	0.06	0.07	4.30	4.24	4.40	0.62	0.53	40	0.45
APR 18...	320	0.48	18	0.02	--	0.98	0.96	--	--	0.33	40	0.25

DATE	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	CYANIDE DIS-SOLVED (MG/L AS CN)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)
MAR 21...	0.48	2	85	<0.5	<1	<1	<3	4	<0.01	230	2
APR 18...	--	3	77	<0.5	<1	<1	<3	6	<0.01	540	[illegible]

DATE	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	ANTI-MONY, DIS-SOLVED (UG/L AS SB)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	THAL-LIUM, DIS-SOLVED (UG/L AS TL)	ZINC, DIS-SOLVED (UG/L AS ZN)	ARSENIC TOTAL (UG/L AS AS)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA)	BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE)
MAR 21...	41	<0.1	3	<1	5	<1	<1	16	3	100	<10
APR 18...	61	<0.1	28	<1	7	<1	<1	36	--	--	--

DATE	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	BORON, TOTAL RECOV-ERABLE (UG/L AS B)	CYANIDE TOTAL (MG/L AS CN)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI)	ANTI-MONY, TOTAL (UG/L AS SB)	SELE-NIUM, TOTAL (UG/L AS SE)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG)	THAL-LIUM, TOTAL (UG/L AS TL)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
MAR 21...	<1	40	<0.01	5	<1	6	<1	<1	78	0.51	98
APR 18...	--	--	--	--	--	--	--	--	54	3.3	99

06452392 LAKE ANDES NEAR LAKE ANDES, SD

LOCATION.--Lat 43°10'10", long 98°27'35", sec.31, T.97 N., R.64 W., Charles Mix County, Hydrologic Unit 10140101, at bridge on section line road crossing the lake on T.96 and 97 N. boundary.

PERIOD OF RECORD.--September 1983 to April 1986.

REMARKS.--High water created a need to change sampling site to 06452410.

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	TIME	SPECIFIC CONDUCTANCE (US/CM)	PH (STANDARD UNITS)	TEMPERATURE, AIR (DEG C)	TEMPERATURE (DEG C)	TURBIDITY (NTU)	BAROMETRIC PRESSURE (MM OF HG)	OXYGEN, DISSOLVED (MG/L)	OXYGEN, DISSOLVED (PERCENT SATURATION)	HARDNESS (MG/L AS CACO3)	HARDNESS NONCARB WH WAT TOT FLD MG/L AS CACO3
OCT 16...	1215	1600	8.60	13.0	12.0	5.0	723	9.8	96	680	540
NOV 20...	1200	2200	8.10	-10.0	8.0	2.3	735	8.8	78	1100	930
DEC 18...	1300	1950	7.60	-10.0	1.0	2.2	734	0.8	6	800	610
JAN 08...	1215	2100	7.90	2.0	1.0	2.7	731	4.6	34	--	--
FEB 19...	1230	2060	--	-5.0	1.0	4.5	716	10.6	80	--	--
MAR 19...	1500	1600	8.30	-2.0	4.0	4.5	729	12.8	103	680	530
APR 16...	1045	1490	8.30	7.0	2.0	10	726	12.5	95	610	460

DATE	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	PERCENT SODIUM	SODIUM ADSORPTION RATIO	POTASSIUM, DISSOLVED (MG/L AS K)	ALKALINITY LAB (MG/L AS CACO3)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)
OCT 16...	170	63	79	19	1	53	144	650	54	--	22	1240
NOV 20...	270	100	110	17	2	62	153	1300	120	--	21	2240
DEC 18...	200	74	--	18	2	61	191	800	71	<1.0	27	1510
JAN 08...	190	79	100	21	2	64	188	850	71	--	26	1600
FEB 19...	190	74	96	21	1	63	210	850	73	--	29	1570
MAR 19...	170	63	78	18	1	51	155	680	67	--	21	1250
APR 16...	150	56	71	19	1	47	148	590	49	--	15	1140

DATE	SOLIDS, RESIDUE AT 105 DEG. C, SUSPENDED (MG/L)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	NITROGEN, NITRITE DISSOLVED (MG/L AS N)	NITROGEN, NITRITE TOTAL (MG/L AS N)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	NITROGEN, NO2+NO3 TOTAL (MG/L AS N)	PHOSPHORUS, TOTAL (MG/L AS P)	PHOSPHORUS, DISSOLVED (MG/L AS P)	BORON, DISSOLVED (UG/L AS B)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)
OCT 16...	9	1200	1.7	<0.01	--	<0.10	--	--	0.43	290	--
NOV 20...	12	2100	3.0	<0.01	--	<0.10	--	--	0.21	320	--
DEC 18...	1	1400	--	0.01	<0.01	<0.10	<0.10	--	0.22	270	0.201
JAN 08...	13	--	--	0.01	0.01	<0.10	<0.10	--	0.34	--	0.23
FEB 19...	10	--	--	<0.01	0.02	<0.10	0.20	--	0.21	--	0.179
MAR 19...	5	1200	1.7	<0.01	<0.01	<0.10	<0.10	0.23	0.14	260	0.111
APR 16...	--	1100	1.6	<0.01	--	<0.10	--	--	0.06	230	0.034

06452392 LAKE ANDES NEAR LAKE ANDES, SD--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	CYANIDE DIS-SOLVED (MG/L AS CN)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)
OCT											
16...	--	--	--	--	--	--	--	2	--	12	<1
NOV											
20...	--	--	--	--	--	--	--	2	--	30	2
DEC											
18...	--	4	65	<0.5	<1	<1	--	<90	--	13	<5
JAN											
08...	--	5	<100	<10	<10	--	--	1		90	--
FEB											
19...	--	4	<100	<10	<10	--	--	1		40	--
MAR											
19...	0.142	3	53	<0.5	<1	<1	<3	5	<0.01	16	<1
APR											
16...	--	3	41	<0.5	<1	<1	<3	3	<0.01	7	<1

DATE	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	ANTI-MONY, DIS-SOLVED (UG/L AS SB)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	THAL-LIUM, DIS-SOLVED (UG/L AS TL)	ZINC, DIS-SOLVED (UG/L AS ZN)	ARSENIC TOTAL (UG/L AS AS)	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA)	BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE)
OCT											
16...	1100	<0.1	--	--	<1	--	--	20	--	--	--
NOV											
20...	210	<0.1	--	--	<1	--	--	50	--	--	--
DEC											
18...	3200	<0.1	--	<1	--	<1	--	100	--	--	--
JAN											
08...	6800	--	--	1	<1	<1		80		--	
FEB											
19...	3500	--	4	--	--	<1		50		--	
MAR											
19...	1300	<0.1	4	<1	<1	<1	<1	46	2	100	<10
APR											
16...	650	<0.1	9	<1	<1	<1	<1	<3	--	--	--

DATE	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	BORON, TOTAL RECOV-ERABLE (UG/L AS B)	CYANIDE TOTAL (MG/L AS CN)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI)	ANTI-MONY, TOTAL (UG/L AS SB)	SELE-NIUM, TOTAL (UG/L AS SE)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG)	THAL-LIUM, TOTAL (UG/L AS TL)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM
MAR											
19...	<1	270	<0.01	21	<1	<1	1	<1	13	--	98
APR											
16...	--	--	--	--	--	--	--	--	16	--	98
MAY											
07...	--	--	--	--	--	--	--	--	14	0.45	98
JUN											
25...	--	--	--	--	--	--	--	--	11	--	95

06452410 LAKE ANDES BELOW LAKE ANDES, SD

LOCATION.--Lat 43°08'27", long 98°32'57", in SW¼SE¼SE¼ sec.8, T.96 N., R.65 W., Charles Mix County, Hydrologic Unit 10104010l, on upstream side of concrete culvert, 1 mi south and 0.25 mile west of town of Lake Andes.

PERIOD OF RECORD.--May to September 1986.

REMARKS.--This site was selected as an alternative to site 06453292 during periods of high lake levels.

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	TUR-BID-ITY (NTU)	BARO-METRIC PRES-SURE (MM OF HG)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	HARD-NESS (MG/L AS CACO3)
MAY 07...	1215	12	2170	8.10	9.5	14.0	10	719	6.2	64	850
JUN 25...	1230	--	1650	8.39	31.0	24.5	12	718	5.6	72	730
AUG 15...	0745	73	1630	8.36	19.0	22.5	3.4	--	3.7	--	700
SEP 10...	1035	39	1660	8.31	17.0	17.5	2.4	712	6.8	77	730

DATE	HARD-NESS NONCARB WH WAT TOT FLD MG/L AS CACO3	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	PERCENT SODIUM	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY LAB (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)
MAY 07...	680	210	80	90	17	1	55	174	900	85	<24
JUN 25...	580	200	56	67	16	1	43	149	670	59	19
AUG 15...	510	190	54	64	16	1	47	188	630	57	27
SEP 10...	540	200	57	70	16	1	45	197	630	56	5.8

DATE	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, RESIDUE AT 105 DEG. C, SUS-PENDED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	SOLIDS, DIS-SOLVED (TONS PER DAY)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, DIS-SOLVED (MG/L AS P)
MAY 07...	1770	16	--	--	--	<0.01	<0.01	<0.10	<0.10	<0.301	0.171
JUN 25...	1310	14	1200	1.8	--	0.02	--	<0.10	--	--	0.33
AUG 15...	1250	15	1200	1.7	246	0.02	0.02	<0.10	<0.10	0.82	0.75
SEP 10...	1320	6	1200	1.8	139	<0.01	--	<0.10	--	--	0.28

DATE	BORON, DIS-SOLVED (UG/L AS B)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BERYL-LIUM, DIS-SOLVED (UG/L AS BE)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)	COPPER, DIS-SOLVED (UG/L AS CU)	CYANIDE DIS-SOLVED (MG/L AS CN)
MAY 07...	<260	0.145	0.163	4	<100	<10	<10	<1	<50	1	<0.01
JUN 25...	230	0.27	--	7	59	<0.5	<1	<1	<3	1	<0.01
AUG 15...	<10	0.61	0.60	12	92	<0.5	<1	<1	<3	2	<0.01
SEP 10...	260	0.23	--	8	79	<0.5	<1	<1	<3	<1	<0.01

06452410 LAKE ANDES BELOW LAKE ANDES, SD--Continued

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	ANTI-MONY, DIS-SOLVED (UG/L AS SB)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	THAL-LIUM, DIS-SOLVED (UG/L AS TL)	ZINC, DIS-SOLVED (UG/L AS ZN)	ARSENIC TOTAL (UG/L AS AS)
MAY											
07...	40	2	10	<0.1	5	<1	<1	<1	<1	910	<5
JUN											
25...	8	<5	13	<0.1	5	1	1	<1	<1	910	--
AUG											
15...	13	<5	2400	<0.1	5	1	<1	<1	<1	12	12
SEP											
10...	15	<5	2500	0.1	5	1	1	<1	<1	11	--

DATE	BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA)	BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE)	CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD)	BORON, TOTAL RECOV-ERABLE (UG/L AS B)	CYANIDE TOTAL (MG/L AS CN)	NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI)	ANTI-MONY, TOTAL (UG/L AS SB)	SELE-NIUM, TOTAL (UG/L AS SE)	SILVER, TOTAL RECOV-ERABLE (UG/L AS AG)	THAL-LIUM, TOTAL (UG/L AS TL)
MAY										
07...	<100	<10	<1	270	<0.01	<1	<1	1	<1	<1
AUG										
15...	200	<10	<1	270	<0.01	13	1	<1	<1	<1

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	BARO-METRIC PRES-SURE (MM OF HG)	OXYGEN, DIS-SOLVED (MG/L)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION)	ALDRIN, DIS-SOLVED (UG/L)
SEP										
26...	0800	--	1500	8.69	12.5	16.5	--	--	--	<0.01

DATE	CHLOR-DANE, DIS-SOLVED (UG/L)	DDD, DIS-SOLVED (UG/L)	DDE, DIS-SOLVED (UG/L)	DDT, DIS-SOLVED (UG/L)	DI-AZINON, DIS-SOLVED (UG/L)	DI-ELDRIN DIS-SOLVED (UG/L)	ENDO-SULFAN DISSOLV (UG/L)	ENDRIN, DIS-SOLVED (UG/L)	ETHION DISSOLV (UG/L)
SEP									
26...	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

DATE	PCB, DIS-SOLVED (UG/L)	PCN DISSOLV (UG/L)	HEPTA-CHLOR EPOXIDE DIS-SOLVED (UG/L)	HEPTA-CHLOR, DIS-SOLVED (UG/L)	LINDANE DIS-SOLVED (UG/L)	MALA-THION, DIS-SOLVED (UG/L)	METH-OXY-CHLOR DISSOLV (UG/L)	METHYL PARA-THION, DIS-SOLVED (UG/L)	METHYL-TRI-THION DISSOLV (UG/L)
SEP									
26...	<0.1	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

DATE	MIREX, DIS-SOLVED (UG/L)	PARA-THION, DIS-SOLVED (UG/L)	PER-THANE DISSOLV (UG/L)	SILVEX, TOTAL (UG/L)	TOX-APHENE, DIS-SOLVED (UG/L)	TRI-THION DISSOLV (UG/L)	2,4-D, TOTAL (UG/L)	2, 4-DP TOTAL (UG/L)	2,4,5-T TOTAL (UG/L)
SEP									
26...	<0.01	<0.01	<0.1	<0.01	<1.0	<0.01	0.05	<0.01	<0.01